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Space/COHMEX Data Inventory Document

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K. R. Knupp, and J. E. Arnold

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Information Office**

1987

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SPACE / COHMEX DATA INVENTORY DOCUMENT

by

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1.0 INTRODUCTION

The Satellite Precipitation And Cloud Experiment (SPACE) sponsored by the National Aeronautics and Space Administration (NASA) / Marshall Space Flight Center (MSFC) was conducted during June and July 1986. This field program ran concurrently with the MIcroburst and Severe Thunderstorm (MIST) program, sponsored by the National Science Foundation (NSF), and the FAA-Lincoln Laboratory Operational Weather Study (FLOWS), sponsored by the Federal Aviation Administration (FAA). All three experiments formed a comprehensive and unique data base for the study of remote sensing and convection under the acronym COHMEX (COoperative Huntsville Meteorological EXperiment). Please refer to the SPACE Experiment Design document (Arnold, et al., 1986) for further details and facilities in the SPACE portion of the experiment.

This document supersedes the Preliminary Data Document (NASA/MSFC, 1986) published October 1986, and contains additional information concerning data sets and daily atmospheric conditions throughout the project. Some data sets described in this document are currently being archived and quality assured, and may not be available for distribution at the time of this printing. Although this is the final data document, erratas or addendums may be issued at a later date.

Section 2.0 contains a brief overview of the field program facilities and activities. A description of the types of data collected with sample data products where applicable are provided. The intent is to acquaint the scientist with formats of data products to assist in research activities. This overview is sub-divided into six major data categories; 1) sounding systems, 2) radars, 3) high altitude aircraft based remote sensors, 4) aircraft, 5) satellite, and 6) surface systems.

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The largest section (3.0) presents daily meteorological conditions and summaries of data collected during the experiment. A synoptic overview of the field program is included. Daily summaries provide the following information: 1) synoptic, cloud/precipitation overviews; 2) 1200 GMT National surface and 500 mb maps; 3) aircraft/remote sensor, rawinsonde, radar, and satellite operations; 4) hourly data collection activities; 5) a visible or infrared satellite image; 6) a rawinsonde sounding (skew-T diagram); 7) a 24-h lightning density summary; and 8) a 24-h precipitation map. These summaries provide an insight to the scientist in selecting research days and data requirements.

Appendix A displays the flight tracks of the two high altitude, remote sensing aircraft (the NASA ER-2, and the NASA U2-C). Please note that some of the flights did not occur over the SPACE region. There were a number of ER-2 and U2-C flights off the Virginia coast. These flights were supported by the SPANDAR radar installation at Wallops Island, VA (Table A-1). In addition, there was one ER-2 flight along the east coast of Florida and a U2-C lightning investigation flight centered over Kentucky. Appendix B supplies a complete list of acronyms (LOA) used in this document. Appendix C contains a list of investigators and major participants who took part in COHMEX. *This list is not intended to be a complete list of COHMEX participants, but rather individuals that could provide information and insight on respective data sets.* The appendix provides address and telephone numbers to obtain data information, and request data sets.

Any comments or questions concerning the data should be directed to the SPACE data manager. All data requests must be submitted in writing to:

SPACE Data Manager
NASA/MSFC Mail Code ED-43
Earth Science and Applications Division
Marshall Space Flight Center, Alabama 35812

Telephone: (205) 544-1650
(FTS) 824-1650

References

Arnold, J.E., Wilson, G.S., Williams, S.F., and McNider, R.T., 1986: *Satellite Precipitation and Cloud Experiment, Experiment Design Document.* Johnson Research Center, University of Alabama in Huntsville, Alabama. 150 pp.

Satellite Precipitation and Cloud Experiment: Preliminary Data Inventory Document. NASA Marshall Space Flight Center, Alabama. October 1986.

2.0 OVERVIEW OF FIELD PROGRAM COMPONENTS AND ACTIVITIES

2.1 SOUNDING SYSTEMS

2.1.1 Rawinsonde

Conventional upper air soundings were taken from a combination of three rawinsonde networks as shown in Fig. 2.1-1. The stations and locations are described in Table 2.1-1. Over 1,100 soundings were taken during the field program, and Fig. 2.1-2 shows the distribution of these soundings by station and date.

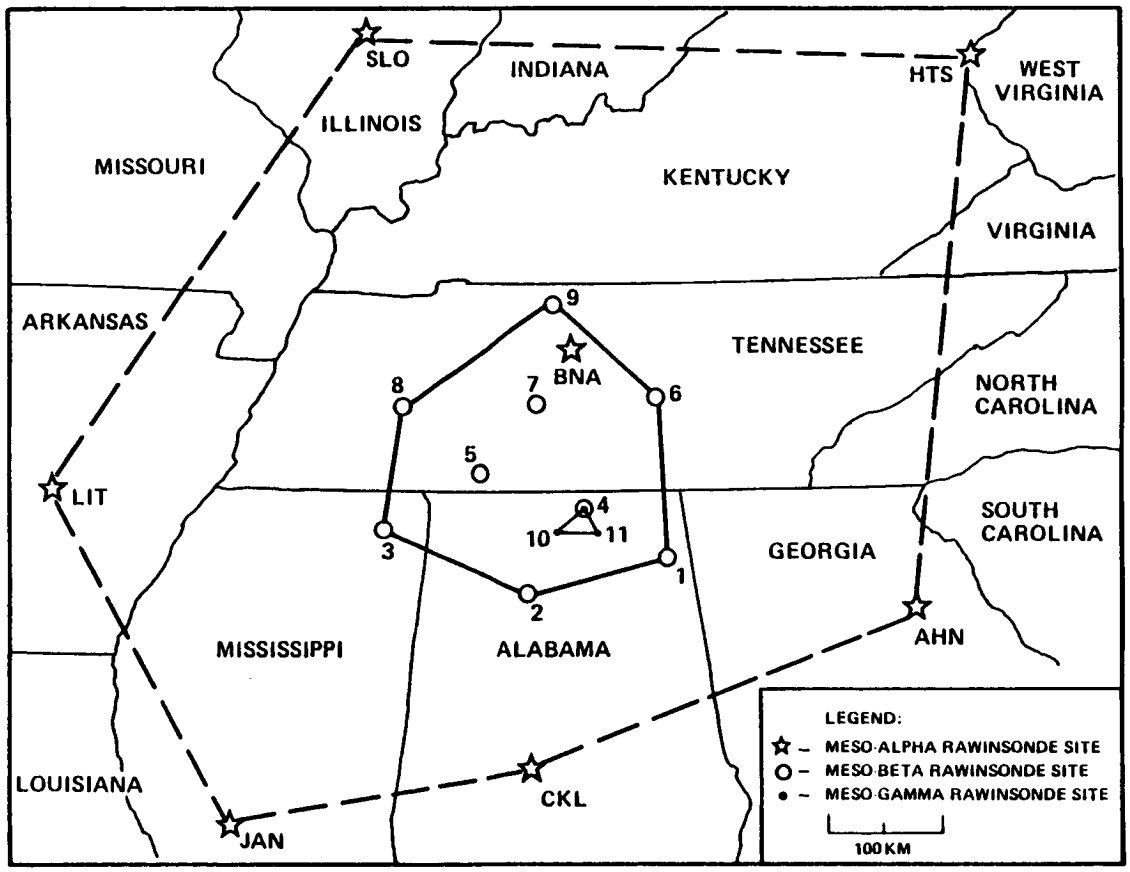


Figure 2.1-1 COHMEX rawinsonde network.

The U.S. Army (Redstone Arsenal, AL) released a sounding each morning (1200 GMT) for forecasting purposes. An early afternoon release (1800 GMT) established a climatological data base and provided local support for COHMEX operations. Additional releases occurred when meteorological conditions warranted, or to augment the Meso-gamma network. The daily 1800 GMT sounding, when available, is presented in Section 3.2.

Table 2.1-1 SPACE Rawinsonde Network

Site No.	Site Name	Latitude	Longitude	Elevation Above MSL ft (m)
	Meso-alpha Network			
72229	Centerville, AL	32.0000	87.2300	459 (140)
72235	Jackson, MS	32.3300	90.0800	328 (100)
72311	Athens, GA	33.9400	83.3200	807 (246)
72327	Nashville, TN	36.2500	86.5700	590 (180)
72340	Little Rock, AR	34.7400	92.2400	260 (079)
72425	Huntington, WV	38.3600	82.5400	807 (246)
72433	Salem-Leckrone, IL	38.6600	88.9800	574 (175)
	Meso-beta Network			
1	Rainsville, AL	34.4567	85.8608	1230 (375)
2	Double Springs, AL	34.1436	87.3378	750 (229)
3	Booneville, MS	34.5936	88.6478	385 (117)
4	Hazel Green, AL	34.8672	86.7075	815 (248)
5	St. Joseph, TN	35.0258	87.4803	810 (247)
6	McMinnville, TN	35.7033	85.8392	1040 (317)
7	Columbia, TN	35.7153	86.9633	722 (220)
8	Lexington, TN	35.6514	88.3828	505 (154)
9	Springfield, TN	36.5444	86.9183	710 (216)
	Meso-gamma Network			
4	Hazel Green, AL	34.8672	86.7075	815 (248)
10	Athens, AL	34.7097	87.0894	655 (200)
11	Redstone Arsenal, AL	34.6100	86.6317	570 (174)
12	MSFC, AL*	34.6250	86.6458	596 (182)

* The Marshall Space Flight Center station was used for special releases and as a substitute Meso-gamma network station.

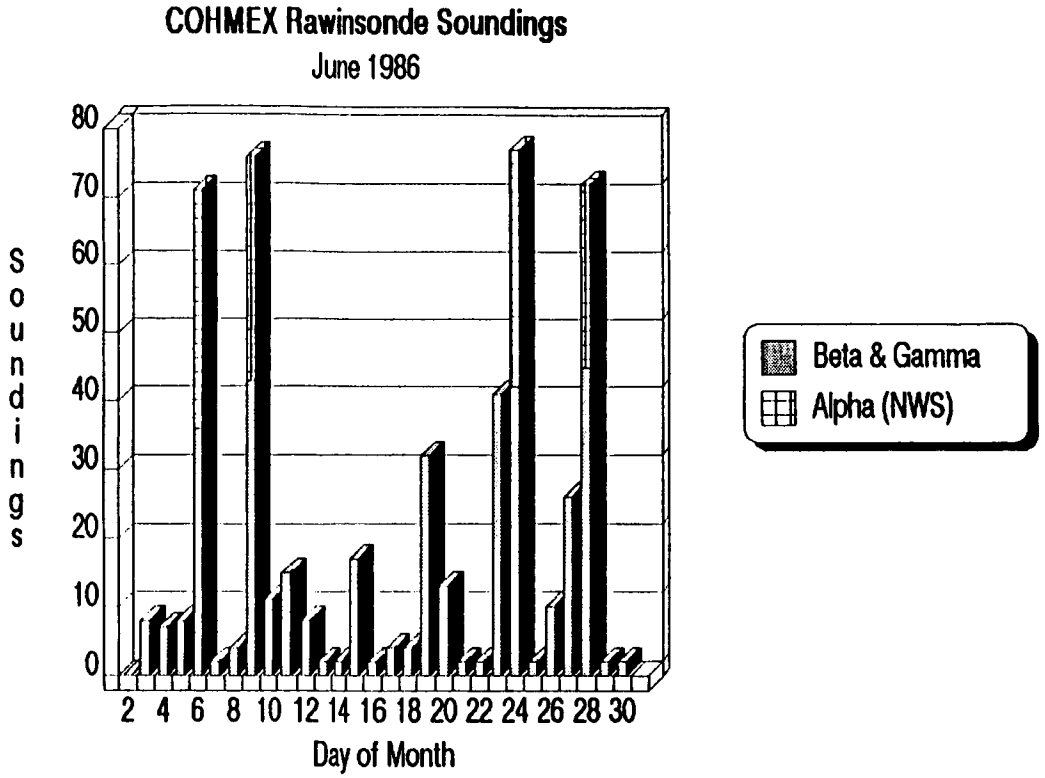


Fig. 2.1-2a Daily frequency of SPACE rawinsonde soundings for June, 1986.

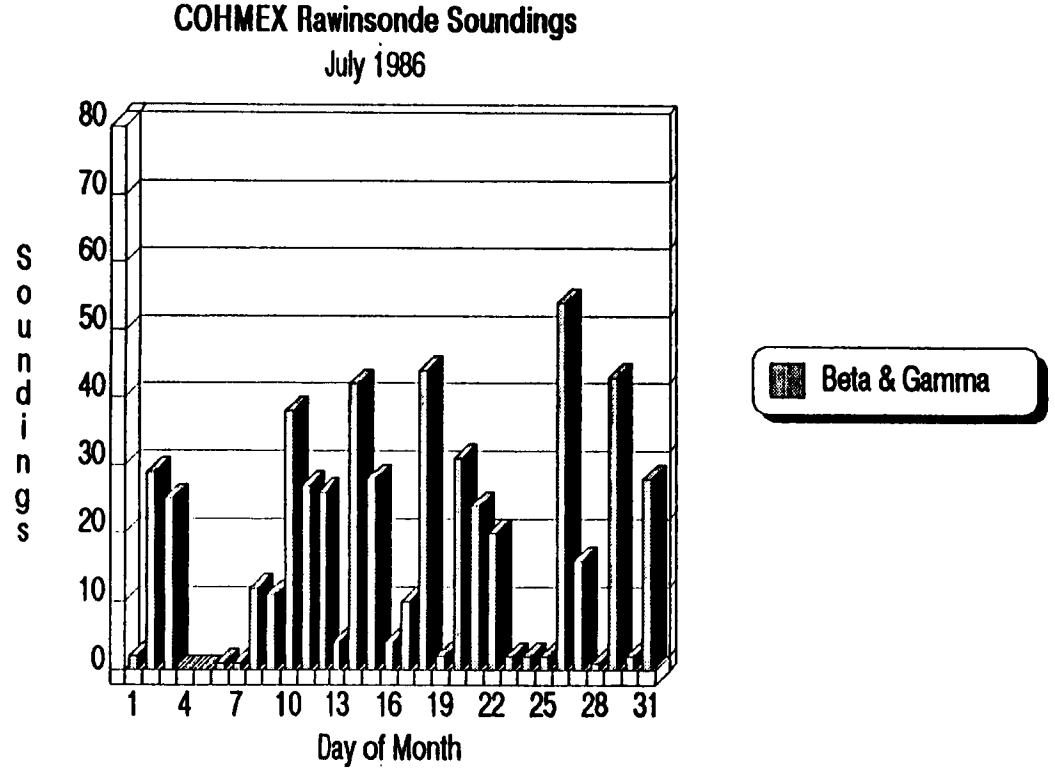


Fig 2.1-2b. Daily frequency of SPACE rawinsonde soundings for July, 1986. Note: There were no Alpha soundings taken during July 1986.

The Meso-alpha network (existing National Weather Service NWS stations) released soundings on a three hour schedule from 1200 GMT to 0600 GMT during four days in June. These special releases followed normal NWS rawinsonde launch and tracking procedures. Soundings were released approximately 1 h prior to designated sounding times (i.e. a 1200 GMT sounding was released at 1100 GMT).

The Meso-beta and Meso-gamma rawinsonde networks were configured to release soundings in three hour intervals between 1500 GMT and 0300 GMT on a full operational day. Sub-portions of these networks were activated or special soundings released depending upon meteorological conditions. Complete soundings are comprised of data from the surface up to balloon burst, typically a level of 25 mb. Normal tracking time for these soundings was 90-100 min with an ascent rate of 5 m s^{-1} (1000 ft min^{-1}). Special soundings taken on a 1.5 h frequency schedule were terminated at 100 mb, or approximately 1 h following release. Soundings were released at approximately 45 min before the designated sounding times (i.e. a 1500 GMT sounding was released at 1415 GMT). This procedure was implemented to center flight duration at designated sounding times. A concerted effort was made to avoid releasing a radiosonde into a thunderstorm, therefore some release times may vary around the designated sounding times.

The raw thermodynamic and wind angle data are being processed in the same manner as previous NASA Atmospheric Variability Experiment (AVE) data. A description of the procedures and details of the data processing can be found in Fuelberg (1974). The sounding data are available in both contact and interpolated 25-mb format. Final Data sets are archived in ASCII fixed block and record length files.

References

Fuelberg, H.E. ,1974: *Reduction and Error Analysis of the AVE II Pilot Experiment Data.* Center for Applied Geosciences Texas A & M University, College Station, Texas. 131 pp.

2.1.2 Raman Lidar

Raman scattering is weak molecular scattering whose wavelength is shifted from the incident radiation by a fixed amount associated with rotational and/or vibrational-rotational transitions of the scattering molecule. The shift from the laser wavelength is characteristic of specific atmospheric molecules. In the atmosphere, nitrogen, oxygen, water vapor, and carbon dioxide molecules have been observed to produce Raman scattering. Melfi (1972) has shown that the ratio of the Raman-scattered signal for the water vapor shifted to the signal from nitrogen is proportional to the atmospheric specific humidity (units of g kg^{-1}).

The lidar consists of a laser (wavelength 355 nm) and a telescope (diameter 1.5 m) optically aligned with each other. The telescope and laser are mounted in an environmentally controlled van and peer vertically through a hatch in the van's roof. The laser pulse propagates up through the atmosphere and is scattered by molecules and aerosols. Most of the scattering is due to Rayleigh and Mie scattering. However, a small amount is scattered at the shifted Raman wavelengths. The telescope collects the radiation that is scattered back toward the lidar. The collected radiation is filtered and divided into two channels. The first channel has a narrow bandpass filter centered on the Raman shifted wavelength due to water (406 nm) and the second channel has a filtered centered on the Raman shifted wavelength due to nitrogen (387 nm). The signal from each channels provide measure of the atmospheric scattering which can be analyzed to provide a measurement of specific humidity vs. altitude. A more complete description of the Raman lidar is given in Melfi and Whiteman (1985).

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Figure 2.1-3 displays a black and white rendition of lidar derived specific humidity over the Athens, Alabama site (34.7608 N, 86.9786 W), as a function of both time and altitude during the morning of 22 July 1986. The moisture sounding shows the temporal history of the mixing ratio between 0800 - 1000 GMT (0300 and 0500 CDT). The moisture features apparent in this image are:

1. The high moisture associated with the previous days planetary boundary layer. This feature is well mixed and stratified, and extends up to 1.8 km.

2. There is a gradual moistening of the free troposphere in the altitude range between 1.8 km and 4.0 km as the specific humidity changes from 2 g kg^{-1} (at 3:04 am) to 9 g kg^{-1} (5:00 am). It appears that there were two times when moisture increased in this altitude range rather abruptly, first at 3:15 am and again at about 4:00 am.

3. The dry/moist feature at an altitude between 4 and 5 km. The moist feature generally subsides over the two hour period, but begins to rise toward the end of the period.

4. The small scale variation in moisture in the free troposphere. This is seen as a stippled appearance of the moisture above 1.8 km.

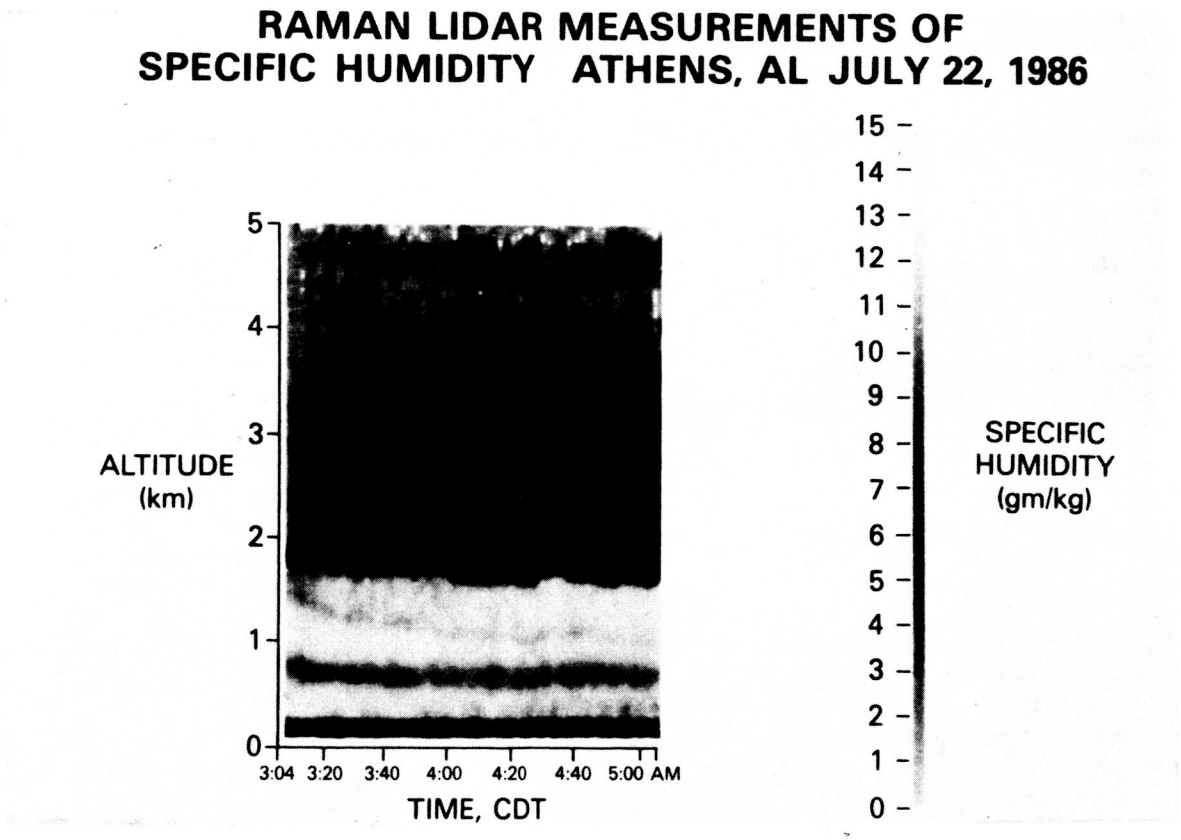


Fig. 2.1-3. Raman lidar depiction of derived specific humidity over Athens, AL on 22 July 1986

References

Melfi, S. H., 1972: Remote Measurements of the Atmosphere Using Raman Scattering, *Appl. Opt.* **11**, 1605-1610

Melfi, S. H., and D. Whiteman, 1985: Observation of Lower-Atmospheric Moisture Structure and its Evolution Using a Raman-Lidar, *Bull. Amer. Meteor. Soc.* **66**, 1288-1292

2.1.3 Ultra High Frequency (UHF) Radar Wind Profiler

A Ultra High Frequency (UHF) Doppler radar wind profiler was co-located with the Raman lidar 5 km south of Athens, Alabama, and about 35 km west of Huntsville (34.7608 N, 86.9786 W). The Doppler radar wind profiler transmitted energy at 405.25 MHz from antenna, separated by 90° in azimuth, at 15° oblique angles from zenith. One of the off zenith beams was oriented 53° (NE) along the radial to the CP-2 radar, while the other was oriented at 323° (NW) from azimuth. The Doppler shifted, backscattered energy is received by each antenna, and the radial velocities are measured along each beam. The horizontal wind components are then computed from the radial velocities (assuming the vertical velocity is zero). The vertical component of the wind is measured directly with a beam directed toward zenith (Augustine and Zipser, 1987). Since there was an abundance of Doppler radars in the near vicinity, the primary focus of the UHF wind profiler was to collect vertical velocity data. However, horizontal wind data was collected throughout the experiment. A characteristic of the UHF wind profiler is its sensitivity to precipitation. This sensitivity was used to determine the size of the hydrometeors since the terminal velocity of a hydrometeor is related to the square root of its diameter. The size estimates can then be compared with the size estimates deduced from the CP-2 Doppler radar (Forbes and Carrol, 1987).

The 405.25 MHz radar operated at a reduced power and therefore, did not normally collect data above 7 km. The attention was focused in the lowest 2.5 km of the storms, where inflow, downdraft, and outflow features were present. Figure 2.1-4 is a time section of wind profiler air vertical velocities during and surrounding the passage of a gust front across the profiler from north-northeast to south-southwest on 31 July 1986. The thunderstorms which produced the outflow remained centered at least 15-20 km from the profiler, and only a brief shower reached the ground at the site. This shower, and other rainshafts aloft, fell from the anvil of a storm to the north and west. The rainshafts were sufficiently isolated, and fell on a slant, so that they only intercepted the vertical beam occasionally. This caused the pockets seen in the figure. Most velocities were output directly from the routine spectrum processing algorithm. Air velocities at locations indicated by a R (rain contamination) or a T (turbulence) were determined subjectively through inspection of the spectra. Upward vertical velocities as large as 6 m s^{-1} and downward vertical velocities as large as 7 m s^{-1} were noted in the immediate vicinity of the gust front. The scanning Doppler radars revealed the passage of a fine line across the profiler accompanying the gust front, traveling at 41 km h^{-1}. Using this value, an approximate horizontal scale has been attributed to the time section.

The horizontal wind for another gust front passage is depicted in Fig. 2.1-5. The figure shows contours of the measured horizontal wind velocities for a gust frontal passage on 25 July 1986. The frontal passage can clearly be seen at 2215 GMT.

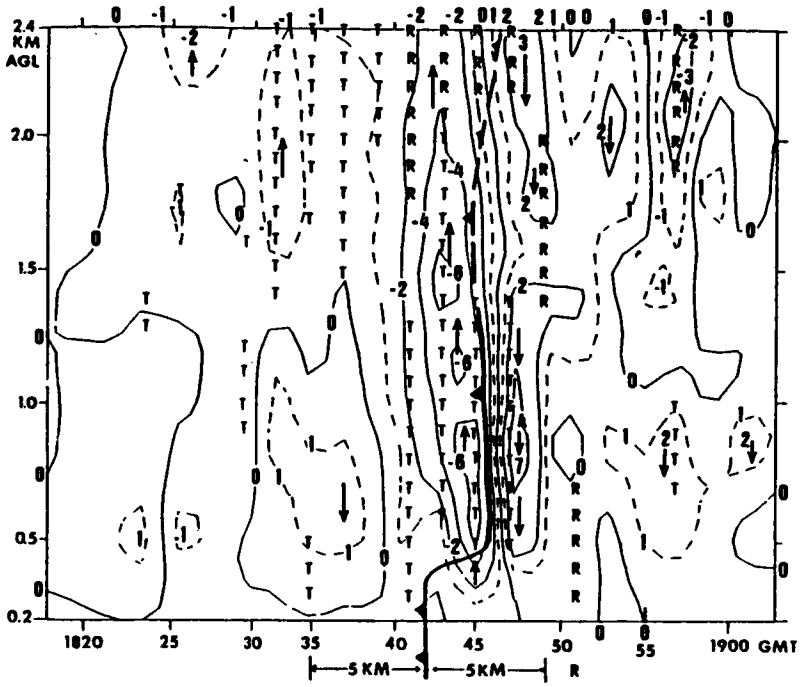


Fig. 2.1-4. Time section of UHF wind profiler-derived air vertical velocity m s^{-1} accompanying and surrounding the passage of a gust front on 31 July 1986. Velocities are output directly from the routine profiler algorithms, except where rain (R) and turbulence (T) yielded erroneous results. In these cases, velocities have been inserted based upon interpretation of the multi-peaked spectrum. Time passage of gust front wind shift, and approximate time-space conversion scale are indicated.

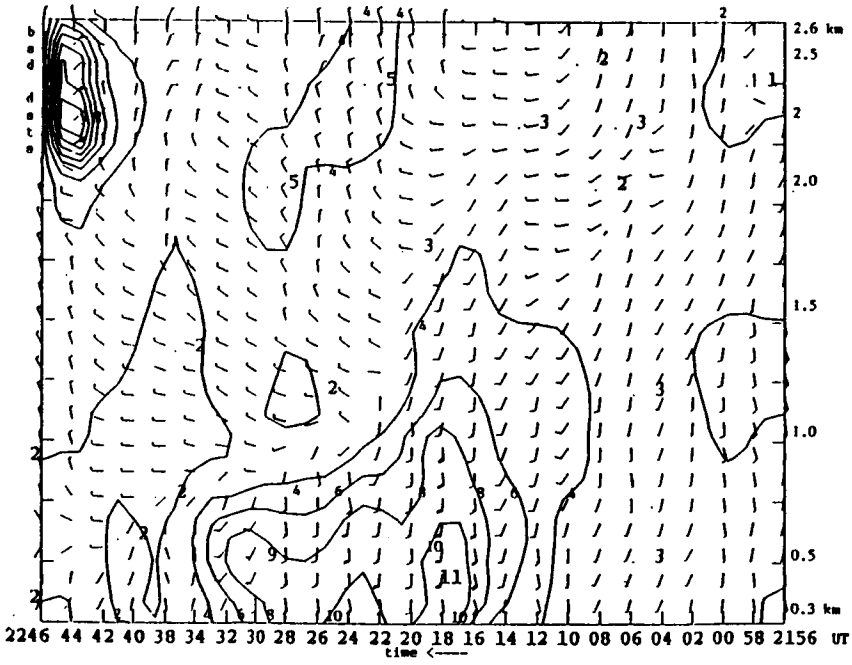


Fig. 2.1-5. Time section of the UHF Doppler wind profiler measured horizontal wind vectors for a gust frontal passage on 25 July 1986.

References

Augustine, J. A. and E. J. Zipser, 1987: The use of wind profilers in a mesoscale experiment. *Bull. Amer. Soc.*, **68**, 4-17

Forbes, G. S. and L. A. Carrol, III, 1987: *Initial results from the Penn State wind profiler in MIST/SPACE*, Department of Meteorology, Pennsylvania State University, University Park, PA

2.1.4 Sodar

A Doppler acoustic sounder (sodar) was co-located with the Doppler UHF wind profiler and the Raman lidar at the Athens, Alabama site (34.7608 N, 86.9786 W).. The sodar operates on the same principle as the UHF wind profiler, except it uses acoustic pulses. The sodar used during the SPACE experiment was a three component system (north-south component, east-west component, vertical component) which sent out a pulse of sound energy at 1600 Hz. The pulse is backscattered to the same antenna by thermal or mechanical turbulence. The effective vertical range of the sodar is limited to less than 1 km, because of the rapid attenuation of sound waves in the atmosphere (Augustine and Zipser, 1987). The sodar operated for most of the period except during precipitation events at the site. As soon as the rainfall subsided the sodar was restored to an operational status.

A gust front is an ideal meteorological phenomena to be measured by a sodar. A gust front is characterized by strong vertical wind shear and a large vertical thermal gradient. The vertical wind shear and thermal gradient provide favorable conditions for acoustic scattering. Figure 2.1-6 is a contoured plot of vertical velocities at the Athens, Alabama sodar site at the time of a gust front passage on 25 July 1986. Figure 2.1-7 is a contoured plot of the horizontal wind vectors for the same time as Fig. 2.1-6. Please refer to Fig. 2.1-5 for a comparison of sodar and wind profiler measured horizontal wind velocities (please note the different z-axis scales).

References

Augustine, J. A. and E. J. Zipser, 1987: The use of wind profilers in a mesoscale experiment. *Bull. Amer. Soc.*, **68**, 4-17

Forbes, G. S., 1987: (personal communication), Pennsylvania State University, University Park, PA.

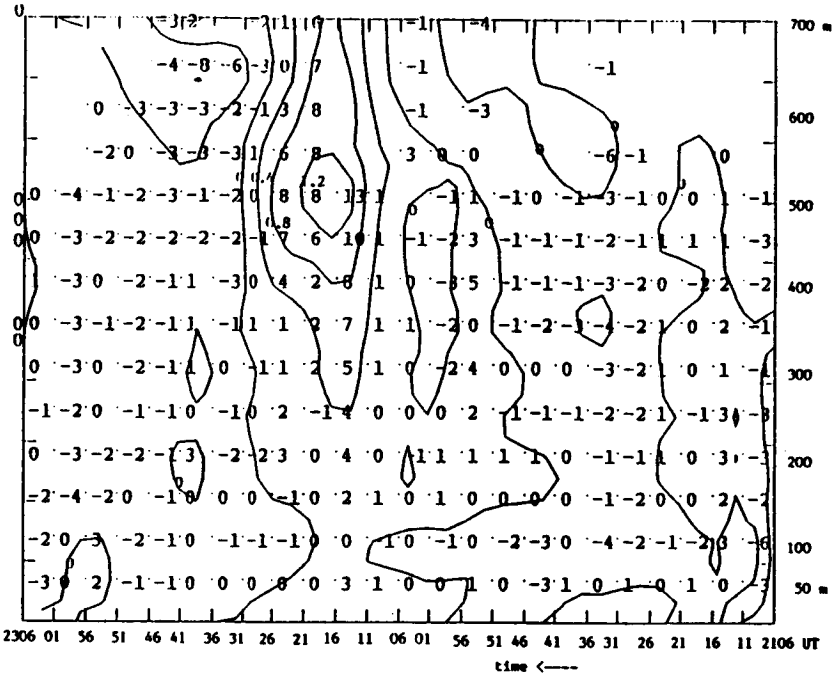


Fig. 2.1-6. Time section of the sodar measured vertical velocites for a gust frontal passage on 25 July 1986.

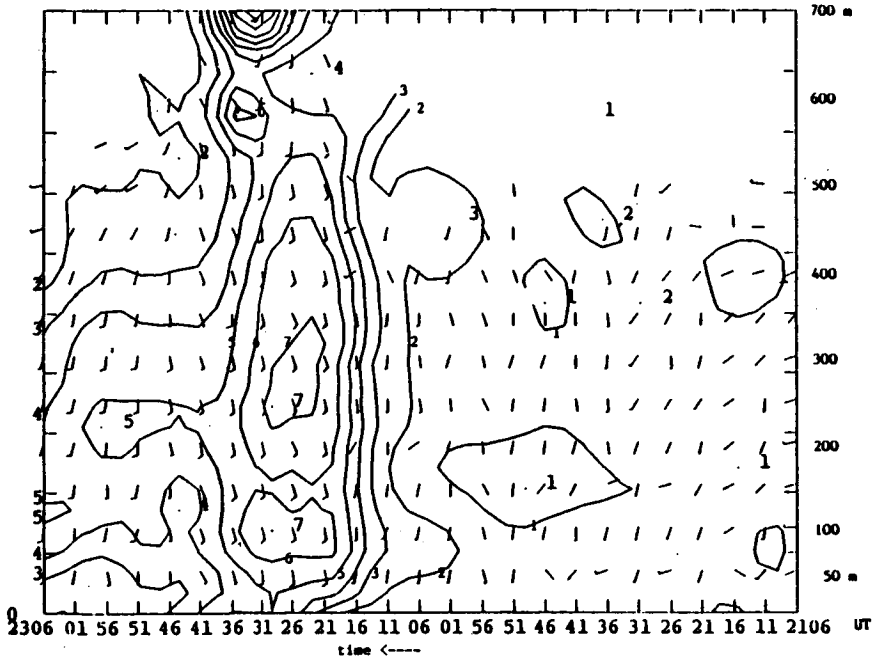


Fig. 2.1-7. Time section of the sodar measured horizontal velocites for a gust frontal passage on 25 July 1986.

2.2 RADARS

Radars available during COHMEX consisted of five research Doppler radars in addition to a RAdar DAta Processor (RADAP) device installed on the Nashville (BNA) WSR-57 radar. Radar locations are shown in Fig. 2.2-1 and listed in Table 2.2-1. General radar characteristics are given in Table 2.2-2. The National Center for Atmospheric Research (NCAR) radars (CP-2, CP-3 and CP-4) were generally under the control of MIST Principal Investigators whenever convective activity was close to or within the MIST network. The two Doppler radars associated with the FLOWS program (FL-2 and UND) typically worked as a pair independent from the NCAR radars. When thunderstorms were either within or very close to the MIST/FLOWS network, FL-2 often sampled to a maximum range of 50 km.

Radar surveillance coverage was provided on large scales under low resolution (2° elevation and azimuth steps, 1 n mi range steps, and 10 min time increments) by the BNA RADAP whenever it was operational. These scans started at an elevation of 0.5° and were incremented upwards to 2, 4, 6, . . ., 22° if echoes were present at higher elevations, and if NWS personnel allowed the cycle to continue automatically. In general, multiple elevation volume scans were acquired systematically during episodes of deep convection. RADAP data were unavailable for two extended time periods in June (June 5 to June 12, and June 15 to 25, and other isolated days - see Section 3.2, Daily Summaries for details) due to hardware problems. An Interactive Color RAdar Display (ICRAD) was ingesting BNA RADAP data at MSFC throughout the field program. The ICRAD data consisted of 3 x 5 nm resolution images of cloud top height, vertical integrated liquid water content, rainfall estimation, and reflectivity.

Additional low-elevation radar surveillance scan coverage was provided by CP-4 at a low elevation scan whenever the MIST radars were operational. These surveillance scans were generally acquired every 6 min at 0.5° elevation at ranges out to 115 km. See Fig. 2.2-1 for coverage area relative to the SPACE mesonet. Sampling resolution was typically ~1° in azimuth and 200 m in range. Surveillance scans were taken less frequently and systematically by the other Doppler radars. UND often implemented NEXRAD full volume scans at multiple elevations. At times when thunderstorms were located beyond 150 km range, CP-2 was used for long-range surveillance scans out to 300 km (0.5 Pulse Repetition Frequency).

Multiple Doppler radar data were acquired only within the stippled rectangle shown in Fig. 2.2-1. As stated earlier, the three MIST/NCAR radars worked independently from the two FLOWS radars due to operational constraints. Quite often, however, common storm volumes were scanned in a non-coordinated fashion. During coordinated multiple Doppler operations, the three NCAR radars attempted to scan the full depth of thunderstorms over a horizontal area of ~200 km^2 at ~2.5 min cycle times. Because of geometrical constraints (baseline effects), it was commonly impossible to cover the entire life cycle of convective cells under ideal multiple Doppler coverage. However, it appears that a great deal of multiple Doppler data were acquired under good temporal and spatial resolution.

When not conducting multiple Doppler scans, the NCAR radars (CP-2 and CP-4 in particular) typically conducted full volume scans on echoes that were within range. Such scans consisted of Plan Position Indicator (PPI), Range Height Indicator (RHI) and Velocity Azimuth Display (VAD) modes. When aircraft operations were taking place, high spatial and temporal resolution radar scans were implemented to provide support whenever possible. In some cases when thunderstorms were located over the MIST network, but aircraft were elsewhere, radar support was much less frequent, but this was generally not a problem.

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Clear air returns were usually very good from the surface upwards to 4-5 km above ground level. Quite often, and particularly under easterly flow conditions, an elevated layer of enhanced reflectivity (apparently from insect backscattering) existed near the 3-4 km level. CP-2 was able to detect clear-air echoes out to 100 km or more, and CP-4 out to 60 km or greater. Such return was valuable in detection of fine-scale wind profiles and perturbations in flow within the clear air around thunderstorms.

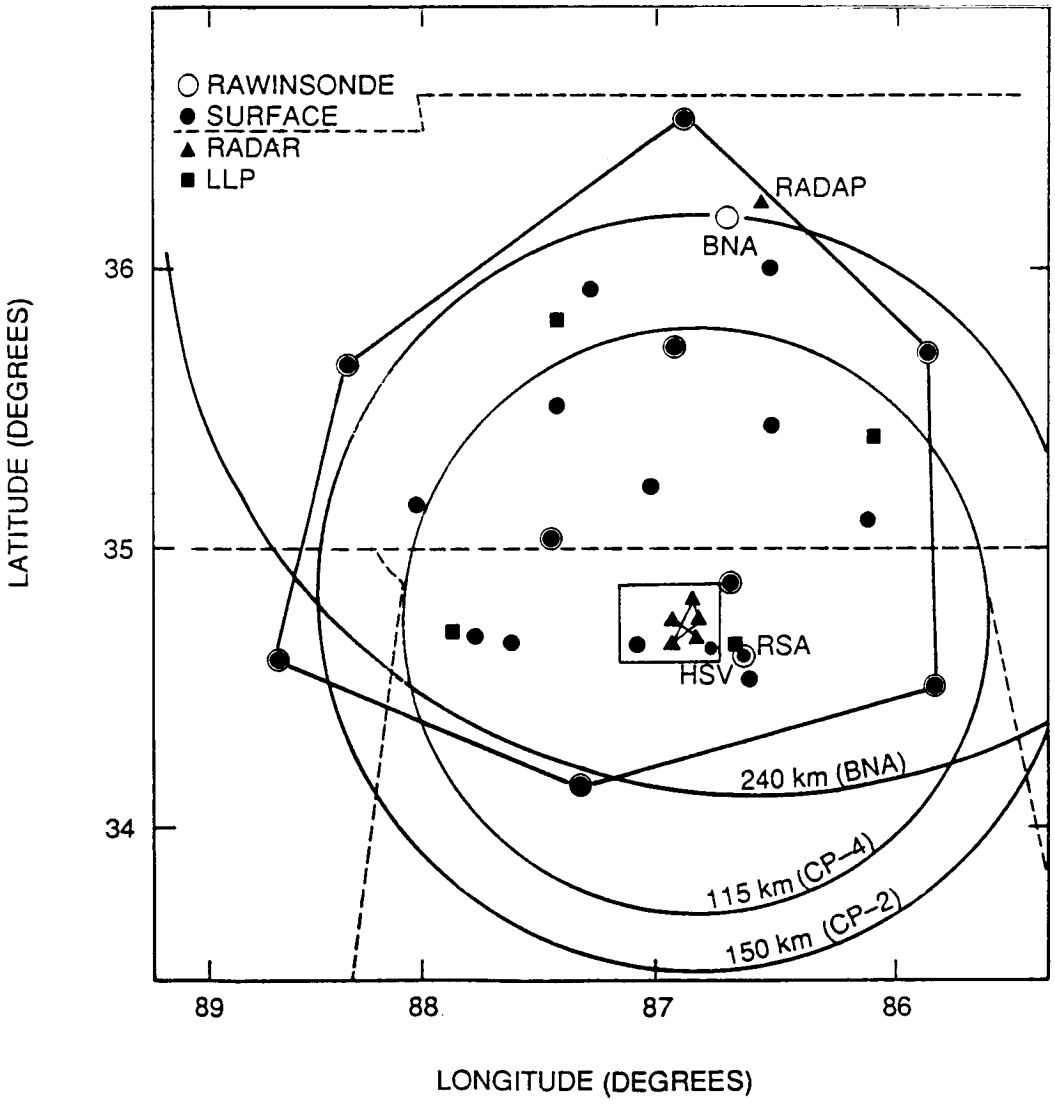


Fig. 2.2-1. Locations of COHMEX radar, rawinsonde, surface, and lightning detection sites. Shaded region represents the MIST/FLOWS mesonet area. Circles represent typical maximum ranges for the designated radars.

Table 2.2-1 COHMEX Radar Network

WBAN No.	Site Name	Latitude (deg N)	Longitude (deg W)	Elevation Above MSL ft (m)
	CP-2	34.8486	86.8325	866 (264)
	CP-3	34.6433	86.9381	604 (184)
	CP-4	34.7217	86.8286	672 (205)
	FL-2	34.6535	86.8053	636 (194)
	UND	34.7425	86.9268	663 (202)
93862	Tupelo, MS	38.3600	82.5400	325 (099)
13897	Nashville, TN	36.2500	86.5700	590 (180)

Table 2.2-2. General parameters of the COHMEX radars.

Radar	Wavelength (cm)	Peak Power (kw)	System Noise Power (dBz)	Beamwidth (deg)	Maximum Range (km)	Measured Parameters
CP-2	10.7/3.2	1200/200	-104/-107	0.93/0.94	156	ZH, ZX, VR, SW, ZDR, LDR, NCP
CP-4	5.5	400	-106	1.11	115	ZH, VR, NCP
CP-3	5.5	400	-104	1.02	?	ZH, VR
FL-2	10.6	1100	-108	0.96	48-200	ZH, VR, SW
UND	5.4	250	-98	0.99	56-226	ZH, VR, SW
RADAP	10.0	410		2.2	240	ZH

Available parameters:
- ZH - Reflectivity factor at horizontal polarization
- ZX - X-band reflectivity factor (CP-2 only)
- VR - Radial velocity
- SW - Width of the Doppler Spectrum (standard deviation)
- ZDR - Differential reflectivity factor (S-band)
- LDR - Linear depolarization ratio (X-band)
- NCP - Normalized coherent power

2.3 AIRCRAFT BASED REMOTE SENSORS

2.3.1 Advanced Microwave Moisture Sounder (AMMS)

The Advanced Microwave Moisture Sounder (AMMS) flew on the ER-2 high altitude aircraft. The AMMS instrument senses microwave radiation in the 92 GHz and 183 GHz frequencies. The image in Fig. 2.3-1 displays the five channels available from the AMMS instrument. The image is a completely processed AMMS photograph, including the effects of calibration smoothing and filtering. The brightness temperatures were converted linearly to a gray scale having 256 levels from black to white. The intensity scale at the top of each picture shows the relationship between temperature and gray scale.

The image is divided into two 22.5 min sections with time increasing from top to bottom. Tick marks are positioned at 1 min intervals. The temperature resolution scale was expanded using a tri-folded gray scale. Each gray scale revolution represents a fifty degree temperature range (130 K to 180 K, 180 K to 230 K, and 230 K to 280 K). The 92A channel is the unfolded 92 GHz channel with an 80 K temperature range. The 92A channel is used as a reference image, since it shows ground features more clearly than the 92 GHz tri-folded swath. The other three channels are all centered around the 183 GHz frequency. The 183 ± 2 GHz channel is the summation absorption of the 181 GHz and 185 GHz frequencies. Likewise, the 183 ± 5 GHz and the 183 ± 9 GHz channels are summations of the 178 GHz and 188 GHz, and the 174 GHz and 192 GHz absorptions, respectively. The 183 ± 2 GHz channel is more sensitive to upper atmospheric moisture than the 183 ± 5 GHz channel. Therefore, the 183 ± 5 GHz channel "sees" moisture at lower levels and is more sensitive to surface features than the 183 ± 2 GHz channel. A similar comparison can be made for the 183 ± 5 GHz and 183 ± 9 GHz channels.

No geometric corrections are applied to the data. The width of the pixels as projected to the ground at the swath border (45° view angle) is twice that at the center of the swath (nadir viewing). The total swath width at the ground is twice the aircraft altitude. The scans are from right to left of the aircraft track. The orientation of the images is as if the observer looked down while facing the rear of the aircraft.

References

Krupp, B. M., D. P. Kaiser, I. Hakkarinen, 1986: *Observations with the Advanced Microwave Moisture Sounder (AMMS) during the 1986 Genesis of Atlantic Lows Experiment (GALE)*, Science Applications Research, Lanham, MD.

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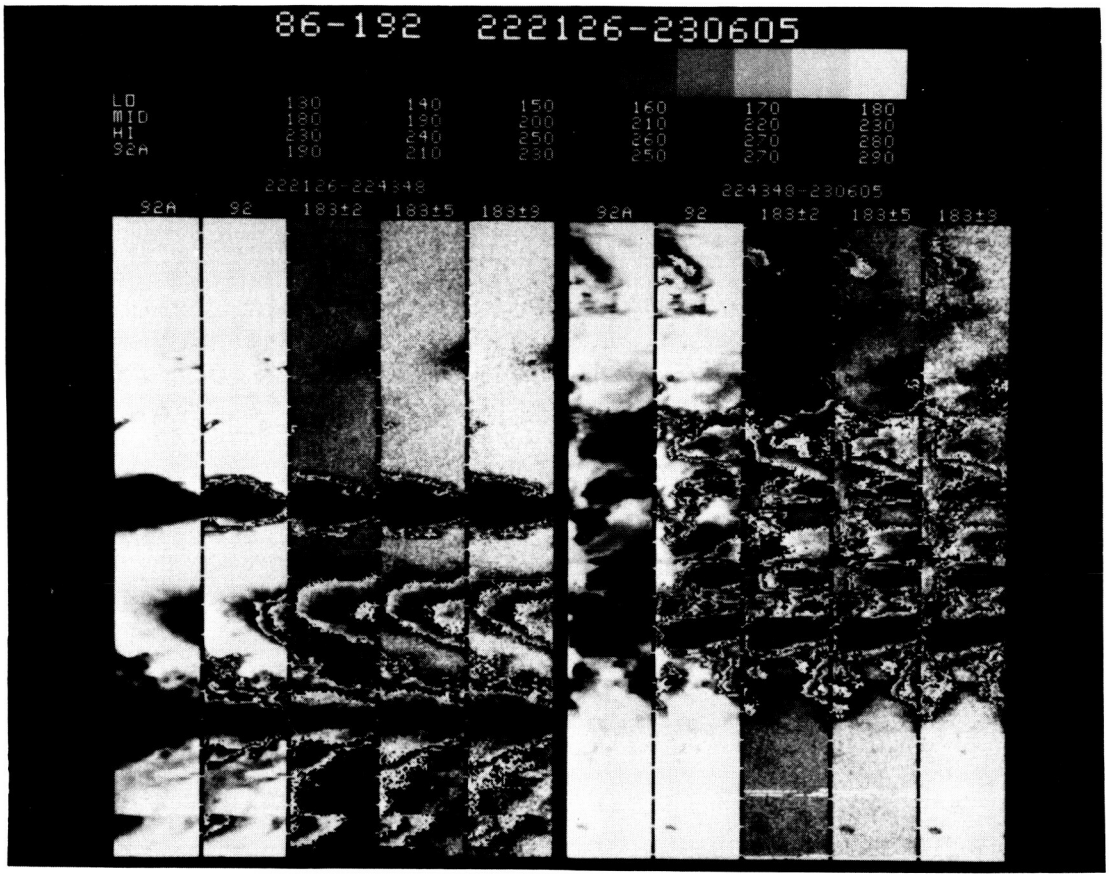


Fig. 2.3-1. A five channel AMMS image (calibrated and filtered) for a flight on the ER-2 on 11 July 1986. The image is divided into two 22.5 min sections with time progressing from top to bottom.

2.3.2 Microwave Precipitation Radiometer (MPR)

The Microwave Precipitation Radiometer (MPR) is an airborne dual polarized radiometer operating at 37 and 18 GHz. The MPR was mounted in a wing pod of the NASA ER-2 high altitude aircraft. The MPR was used to determine the extent to which the scattering produced by precipitation (especially ice) can be used to retrieve rain rates over land and ocean.

Preliminary data analysis has shown scattering from thunderstorms, at 37 GHz, causes brightness temperatures (T_B) to fall below 200 K (compared with a background T_B of about 270 K). On occasion T_B have approached 100 K. The 18 GHz storm signatures also showed strong T_B depressions (to below 200 K).

Figure 2.3-2 shows an example of the 37 and 18 GHz signatures over ocean, wet ground, and storms. Note the difference between the 37 and 18 GHz channels allows discrimination between the wet surfaces (emissive) such as the ocean, and the precipitation (volume scatters). This is because the emissivity of the wet surfaces increases with frequency, while that of the precipitation decreases with frequency.

References

Spencer, R. W., T. T. Wilheit, R. E. Hood, A. T. C. Chang, 1987: Precipitation detection with ER-2 flights of the Microwave Precipitation Radiometer (MPR), *Proceedings of the Second Airborne Science Workshop*, February 3-6, 1987, Miami, FL.

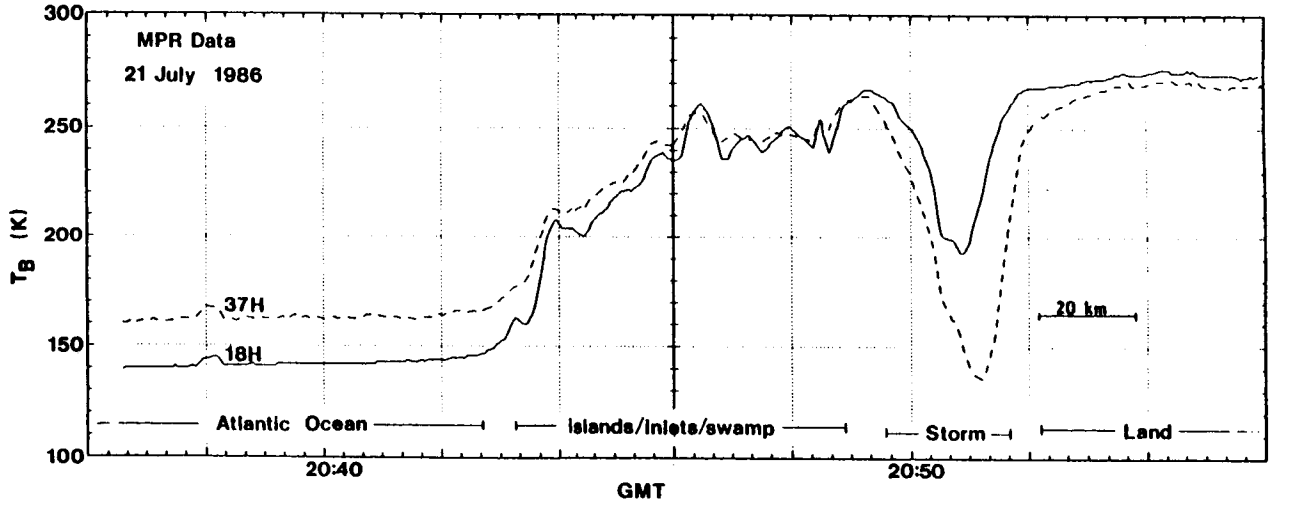


Fig. 2.3-2. MPR data collected 21 July 1986 as the ER-2 made a south to north pass over the Georgia-South Carolina coastline to intercept a storm just inland of the Atlantic Ocean. National Weather Service radars reported a storm height of 12 km with reflectivities exceeding 50 dBZ for this storm. Note the ability of two frequencies to discriminate between the ocean surface (as well as wet land and other water bodies) and the storm. Because a preliminary calibration was used here, brightness temperature depressions could be in error by 10%.

2.3.3 Millimeter-Wave Temperature Sounder (MTS)

The Massachusetts Institute of Technology Millimeter-Wave Temperature Sounder (MTS) is a scanning millimeter-wave spectrometer using eight channels of decreasing opacity (118-75 GHz) oxygen resonance. The MTS flew aboard the NASA ER-2 high altitude aircraft. It performed a cross-track scan approximately every 6 sec, with 14 spots of 7.5° beamwidth per scan. The field of view is $\pm 45°$ from nadir and the atmosphere is uniformly sampled at the mid-altitude height of ~10 km for 200 m s^{-1} airspeed.

The MTS also supports a single channel nadir-viewing fixed-beam radiometer sensing atmospheric emissions in the microwave oxygen absorption complex at 53.7 GHz. The MTS is configured with a wide angle color Charge Couple Device (CCD) video camera and Video Cassette Recorder (VCR) with time-date overlay, providing nadir-viewing optical imagery.

Figure 2.3-3 shows typical brightness temperature structure observed by the MTS during a flight of the NASA ER-2 over the SPACE area. The strip map images reveal strong convective cells, characterized by reductions in radiometric brightness which sometimes exceed 80 K (saturated dark regions). These large negative perturbations in brightness temperature are produced by strong scattering of the cosmic radio background by convected ice near the cloud tops. The perturbations are of less magnitude in the more opaque channels. The most opaque channel (far-right responds only to the most convective and ice laden cells.

The MTS radiometric data sets are approximately 42 min in length. The strip map images are 14 pixels across track and 384 pixels (~ 500 km) along the flight track.

References

Gasiewski, A. J., and Staelin, D. H. 1987: (personal communication), Massachusetts Institute of Technology, Cambridge, MA.

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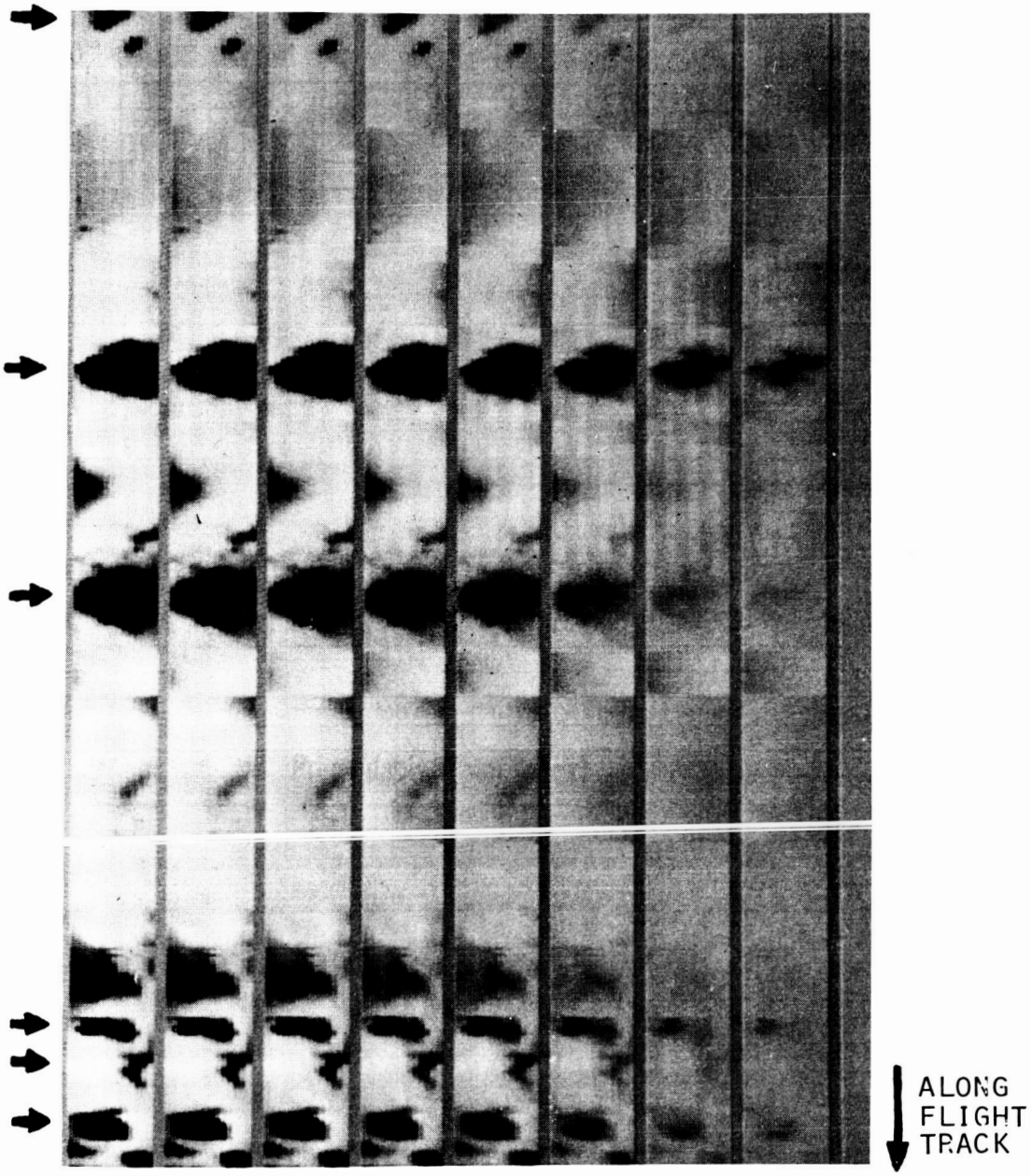


Fig. 2.3-3. An eight channel MTS brightness temperature image from a flight of the NASA ER-2 over the SPACE region. Time progresses from top to bottom along a 42 min (~500 km) flight track. Dark spots (saturated regions) are area in which the radiometric brightness exceeded 80 K.

2.3.4 Multispectral Cloud Radiometer (MCR)

The Multispectral Cloud Radiometer (MCR) is a high resolution radiometer with six narrow bandwidth near-infrared channels and one infrared channel. The instrument was flown on the NASA ER-2 high altitude aircraft and was used for remote sensing of cloud properties. The MCR is mounted downward-facing from the aircraft and actively scans at 3.47 times per second, a field $\pm 45°$ of nadir. All channels are sampled simultaneously with 336 samples across each active scan. The instrument field of view is 7 milliradians. Tables 2.3-1 and 2.3-2 summarize the characteristics and primary functions of each channel.

Figure 2.3-4 is a sample of MCR data from a ER-2 flight on 02 July 1986. All seven MCR channels are shown for the time period 194014 - 194240 GMT. The data were taken along the leading edge of a developing line of thunderstorms. Flight direction was from top to bottom in each image, corresponding to a total distance of about 30 km. Note the clear distinction in channel 5 of ice phase (darker area) and water phase (brighter area). Note from the channel 7 image the corresponding colder cloud top of the ice cloud.

References

Spinhirne, J., 1987: (personal communication), NASA/Goddard Space Flight Center, Greenbelt, MD.

Table 2.3-1 Summary of MCR Channels

Channel Number	Central Wave Number (cm^{-1})	Central Wavelength (um)	Spectral[1] Resolution (um)
1	13271.0	0.75355	0.00093
2	13147.0	0.76063	0.00116
3	13098.0	0.76345	0.00108
4	7340.0	0.3623	0.0088
5	6079.0	1.6451	0.054
6	4630.0	2.1599	0.0894
7	844.0	11.843	1.073

[1] full width at half maximum

Table 2.3-2 Primary functions of MCR channels

Channel No.	Primary Function
1	Visible reflectance, A-band altimetry
2	O_2 A-band altimetry, volume scattering coefficient
3	O_2 A-band altimetry, volume scattering coefficient
4	Water vapor
5	Cloud phase, particle size
6	Cloud phase, particle size
7	Brightness temperature

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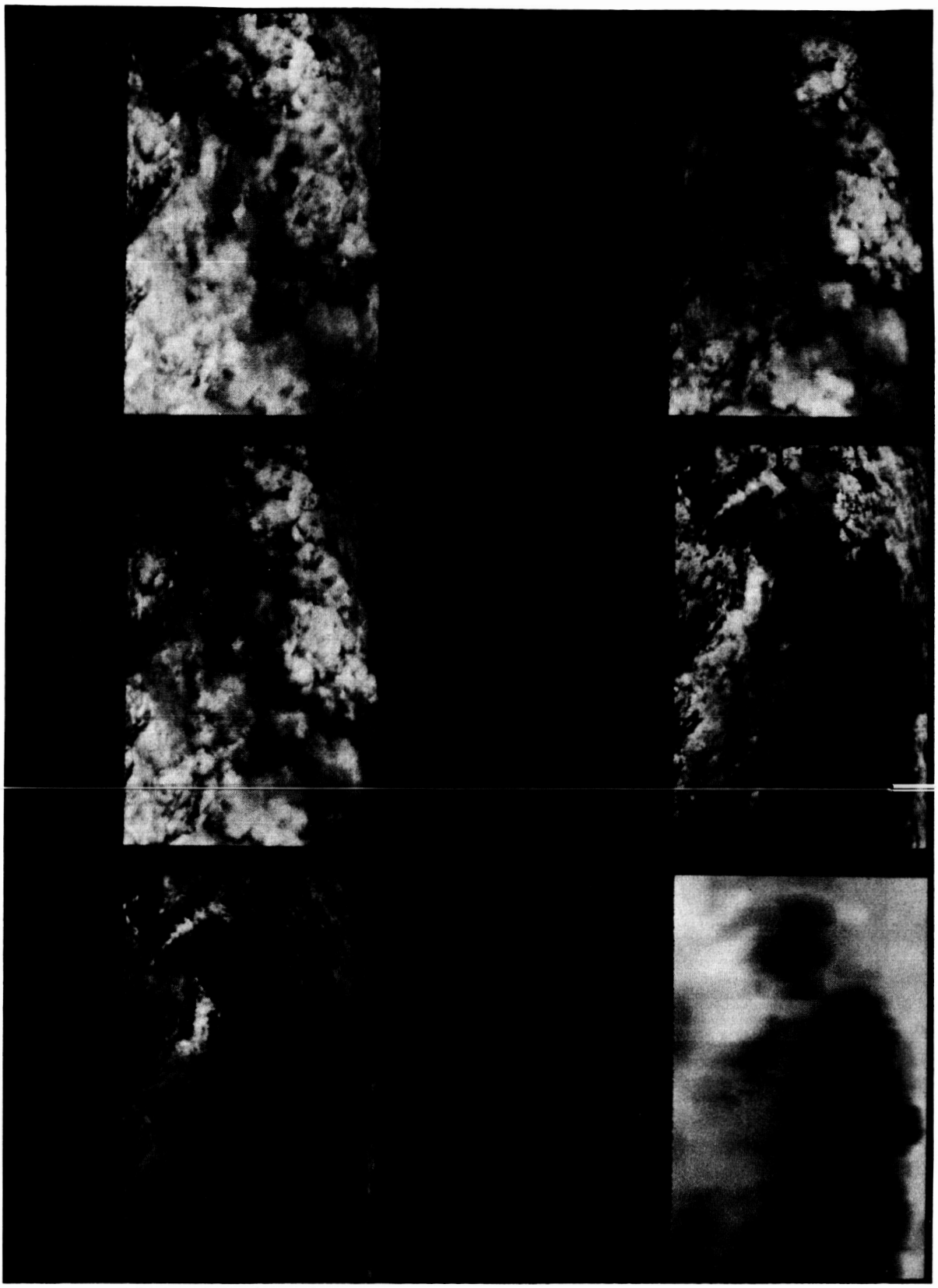


Fig. 2.3-4. An seven channel MCR image from a NASA ER-2 flight on 2 July 1986. Time progresses from top to bottom.

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2.3.5 Cloud and Aerosol Lidar System (CALS)

The Cloud and Aerosol Lidar System (CALS) was flown onboard the NASA ER-2 during the period 17 June to 04 July 1986. The CALS instrument is a nadir viewing lidar system which can obtain the absolute height to cloud and land boundaries. The CALS can determine the structure within cloud tops and the amount of aerosol scattering. The CALS is co-located in a ER-2 superpod with the MCR and is aligned with the MCR nadir pixel.

Figure 2.3-5 is an example of the processed lidar data for 17 June 1986. The image shows the detection of thin cirrus at the tropopause and boundary layer altitude as indicated by the aerosol structure.

References

Spinhirne, J., 1987: (personal communication), NASA/Goddard Space Flight Center, Greenbelt, MD.

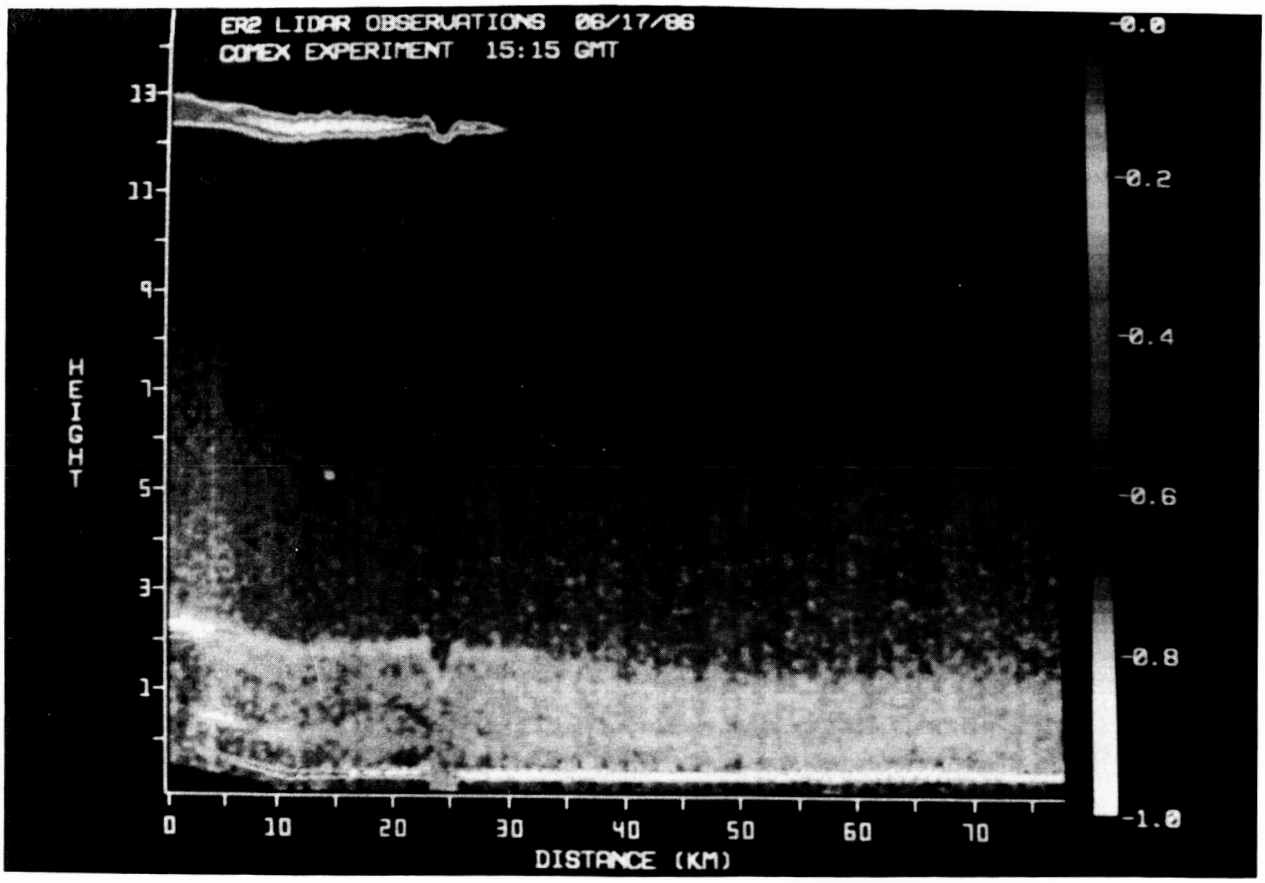


Fig. 2.3-5. CALS image for 17 June 1986. This image shows a thin cirrus layer at the tropopause (12 - 13 km) and the height of the boundary layer as indicated by the aerosol structure.

2.3.6 Lightning Research Package (LRP) and Lightning Instrument Package (LIP)

Observations of the optical and electrical characteristics of cloud top lightning were obtained during SPACE using an integrated complement of sensors flown over active thunderstorms from the NASA high altitude U-2C aircraft. The Lightning Research Package (LRP) sensor complement included two optical pulse detectors, two spectrometers, three imaging sensors, a fast/slow electric field change meter, two electric field mills, and conductivity probes (see Table 2.3-3). Most of the data from these sensors were recorded on an instrumentation tape recorder. The Optical Array Sensor (OAS) and spectrometer data were also digitized on an event by event basis and recorded as a fast Pulse Code Modulation (PCM) bit stream. In addition, data from the electric field mills and conductivity probes were continuously multiplexed and recorded in a slow PCM format. Aircraft locations were obtained throughout the experiment from both an on-board Inertial Navigation System (INS) and a ground based tracking system. Therefore, aircraft lightning measurements can readily be correlated with other ground based and aircraft data sets.

Figure 2.3-6 is an example of the simultaneous optical pulse (Optical Pulse Sensor OPS and Wide Angle Detector WAD) and fast/slow electric field change (Fast Antenna FA and Slow Antenna SA) data for an intracloud discharge event. This observation was obtained on a July 14, 1986. Figure 2.3-7 shows on an expanded time scale the OPS and FA signals for two pulses in this same event.

A Charged Coupled Device (CCD) television camera was installed in the U-2C to collect real time television images of the cloud top structure and lightning discharges. This video data and IRIG-B time were recorded on a video cassette recorder. The camera had a 8 mm lens (FOV of 60°) and selectable interference filter (777.4 or 868.3 nm) for flight and looked through a window in the bottom hatch of the U-2C. The filter used on the television camera is identical to those on the OPD and OAS. The sensor on the television camera is a CCD silicon array (488 lines x 380 pixels). The frame integration time was 33 ms, the frame rate was 30 frames per second, and the synchronization was 2:1 standard interlace.

Two 70 mm Vinten cameras were installed to obtain high quality pictures of the thundercloud tops and associated lightning. Various filters were used to optimize photography based on the selected film for the particular flight period. Based upon the aircraft speed and the 9 s time interval, 92.8 percent overlap occurs on the photos which provides stereo imagery photography. *However, for the COHMEX flight program the normal field of view of the cameras were obscured by the installation of two conductivity probes which were installed just prior to the flight program.*

A small instrument package, the Lightning Instrument Package (LIP), was installed and flown in the nose section of the NASA ER-2 aircraft. Table 2.3-4 lists the sensors included in this package.

References

Blakeslee, R., 1987: (personal communication), NASA/Marshall Space Flight Center, Huntsville, AL.

Vaughan, O. H. Jr., 1984: *NASA Thunderstorm Overflight Program - Atmospheric Electricity Research: An overview Report on the Optical Lightning Detection Experiment for Spring and Summer 1983*, **NASA Technical Memorandum 86468**, November 1984.

Table 2.3-3 Lightning Research Package: NASA U-2C

Sensor	Measurement
Optical Pulse Sensor (OPS)	Optical pulse detection, flash/pulse statistics
Wide Angle Detector (WAD)	Optical pulse detection, flash/pulse statistics
Optical Array Sensor (OAS)	Low resolution image 50x50 photodiode array
CCD-TV	Video image
Vinten Camera	High Resolution photographic image
Broad Band Spectrometer	Lightning spectra (300 nm)
High Resolution Spectrometer	Lightning spectra (30 nm)
Electric Field Change Antenna	Fast/slow electric field changes
Electric Field Mill	Vertical component of electric field Electric field changes
Conductivity Probe	Air conductivity

Table 2.3-4 Lightning Instrument Package: NASA ER-2

Sensor	Measurement
Dual Optical Pulse Sensor (OPS)	Optical pulse detection at two different wavelengths, flash/pulse statistics
CCD-TV	Video image
Electric Field Change Antenna	Fast/slow electric field changes

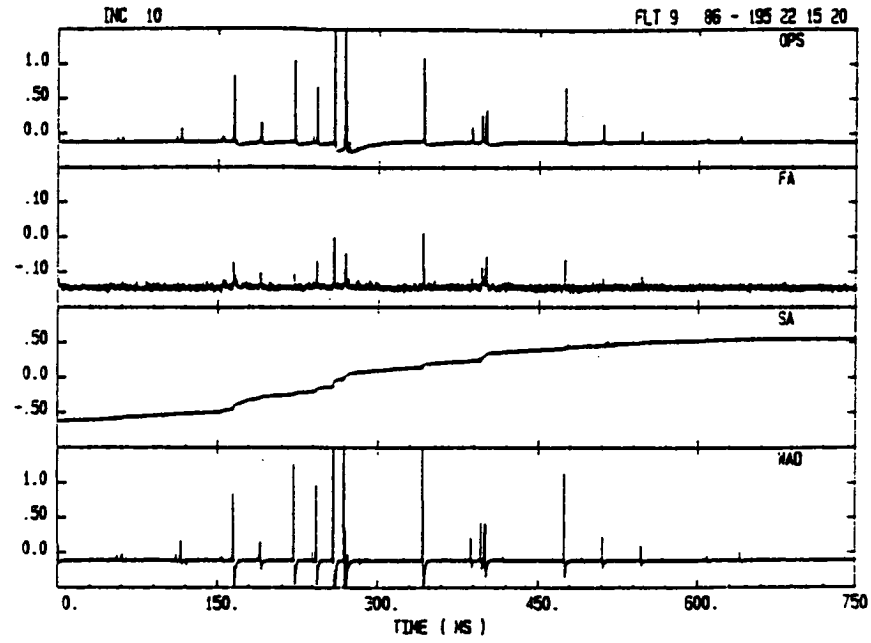


Fig. 2.3-6. Simultaneous optical pulse (OPS and WAD) and fast/slow antenna electric field change data for an intracloud discharge event on 14 July 1986 at 221520 GMT.

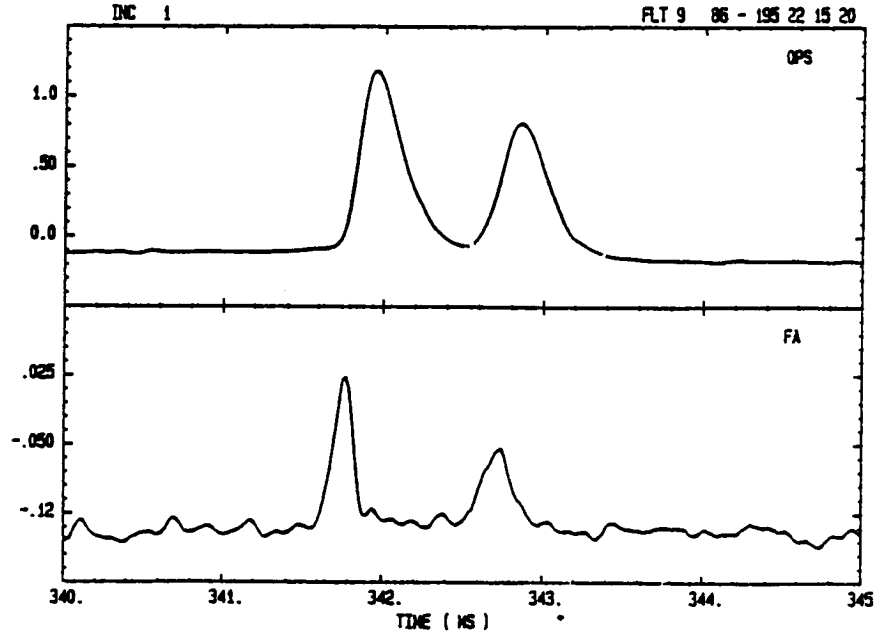


Fig. 2.3-7. Same as Fig. 2.3-6 but on an expanded time scale.

2.3.7 Multispectral Atmospheric Mapping Sensor (MAMS)

Figure 2.3-8 shows data from the 12 channels of the Multispectral Atmospheric Mapping Sensor (MAMS) on 26 June 1986. The displayed data presents reflected solar energy in the visible/near-infrared (channels 1-8) and thermal emission from the earth, atmosphere, and clouds in the infrared (channels 9 - 12). Half power wavelengths for each channel are given below each image strip. Data from MAMS are collected simultaneously through the same optical configuration for all 12 channels and provides 100 m nadir resolution over a swath width of 36km. Data from each channel has been subsampled by a factor of 8 for display purposes.

The MAMS is primarily used to determine surface thermal heat fluxes, land scene classification, and low-level water vapor mapping in the cloud-free environment. During the twenty-one minutes of data presented in the figure, a decaying thunderstorm was sampled. Reflected light from the cloud tops saturate the sensor in some of the visible channels, however valuable infrared measurements of cloud top thermal structure and surrounding atmospheric moisture variability is available.

Figure 2.3-9 shows higher resolution MAMS data for selected channels for the region in the rectangular box of Fig. 2.3-8. The full resolution data are subsampled by a factor of 2 in this display. This figure covers a portion of Huntsville, Alabama and the Tennessee River valley. Reflectivity differences between clouds, vegetation, and water can be observed in the visible channel. The water vapor channel measures energy emitted by mid-tropospheric water vapor and shows mesoscale variability throughout the scene. The driest mid-tropospheric air lies to the south (bottom) of the Tennessee River valley. The right hand side of the image presents channels 10 and 11 which both measure energy emitted from the earth's surface and clouds at 11 micrometers Channel 10 was set such that it measured cold temperatures and 11 warm temperatures. Therefore a large combined dynamic temperature range can be achieved with sufficient sensitivity for qualitative work In the cold channel varying cloud top temperatures can be observed while the warm channel indicates varying surface temperature (see Jedlovec et al., 1986a,b and Menzel et al., 1986 for more information).

References

Jedlovec, G. J., W. P. Menzel, R. J. Atkinson, G. S. Wilson, and J. Arvesen, 1986: *The Multispectral Atmospheric Mapping Sensor (MAMS): Instrument description, calibration, and data quality.* **NASA Technical Memorandum 86565**, Marshall Space Flight Center, Huntsville, AL, 37pp.

Jedlovec, G. J., W. P. Menzel, G. S. Wilson, and R. Atkinson, 1986: Detection of mountain induced mesoscale wave structures with high resolution moisture imagery. *Second Conference on Satellite Meteorology / Remote Sensing and Applications*, AMS, Boston, 365-369.

Menzel, W. P., G. J. Jedlovec, G. S. Wilson, 1986: Verification of small scale features in VAS imagery using high resolution MAMS imagery. *Second Conference on Satellite Meteorology / Remote Sensing and Applications*, AMS, Boston, 108-113.

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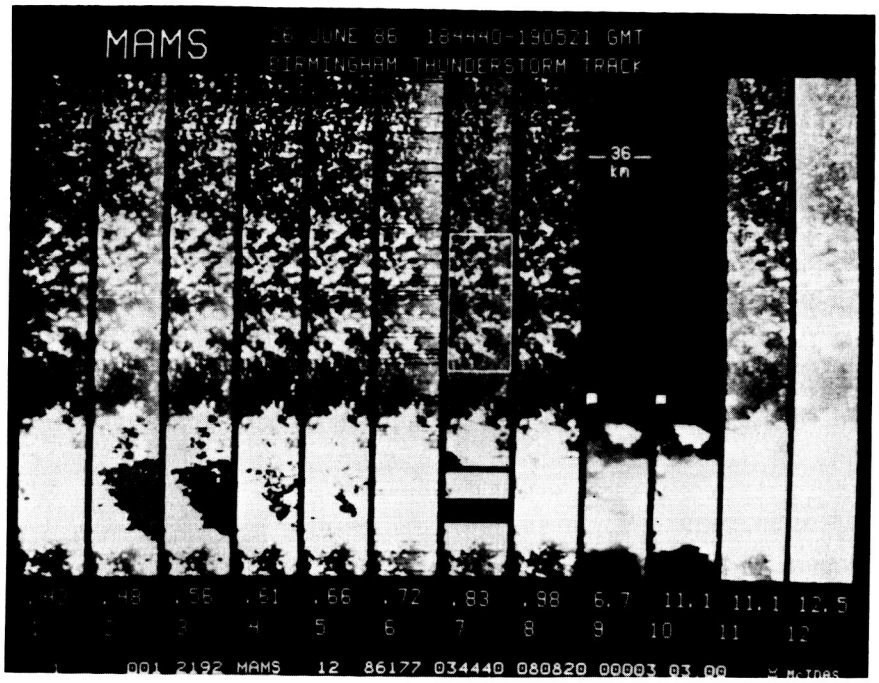


Fig. 2.3-8. MAMS image on 26 June 1986 over the SPACE region. Channels 1-8 presents reflected solar energy in the visible/near infrared wavelengths. Channels 9-12 presents thermal emission from the earth, atmosphere and clouds in the near infrared wavelengths.

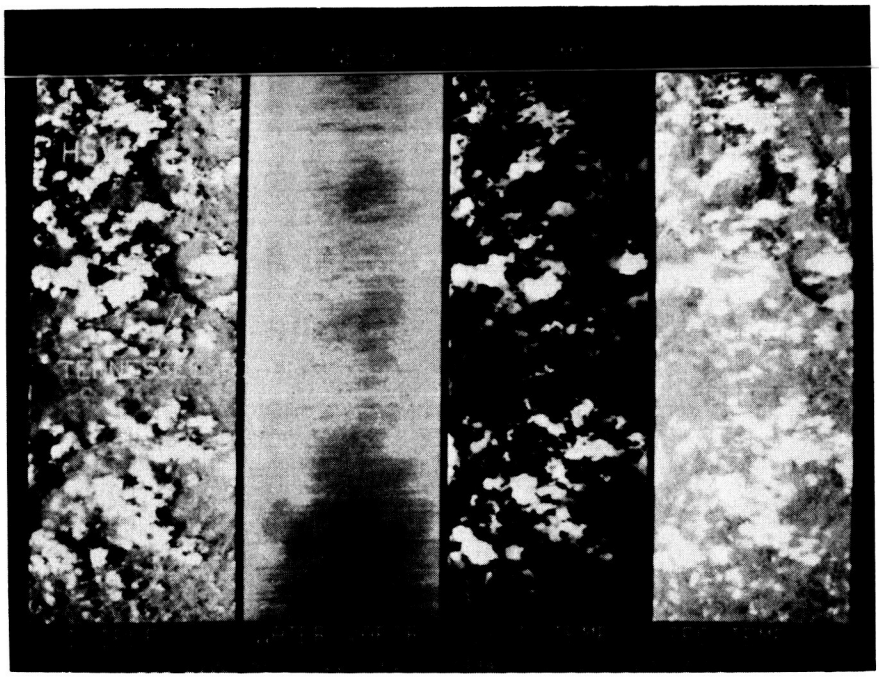


Fig. 2.3-9. Same as Fig. 2.3-8 except only channels 7, 9, 10, and 11 at a higher resolution.

2.3.8 High-resolution Interferometer Sounder (HIS)

Figure 2.3-10 presents data from the High-resolution Interferometer Sounder (HIS) for 15 June 1986 at 1910 GMT. The data have been processed to present a spectral distribution of emitted energy from the earth and atmosphere. Energy units have been converted to brightness temperatures for display. The HIS obtains radiance measurements in three bands; band 1 from 600 to 1100 cm^{-1} (16.7 to 9.1 micrometers), band 2 from 1100 to 1800 cm^{-1} (9.1 to 5.6 micrometers), and band 3 from 2000 to 2600 cm^{-1} (5.6 to 3.7 micrometers). These high spectral resolution measurements are observed every six seconds and are used to infer surface and atmospheric temperature structure, and the distribution of various gaseous and cloud constituents.

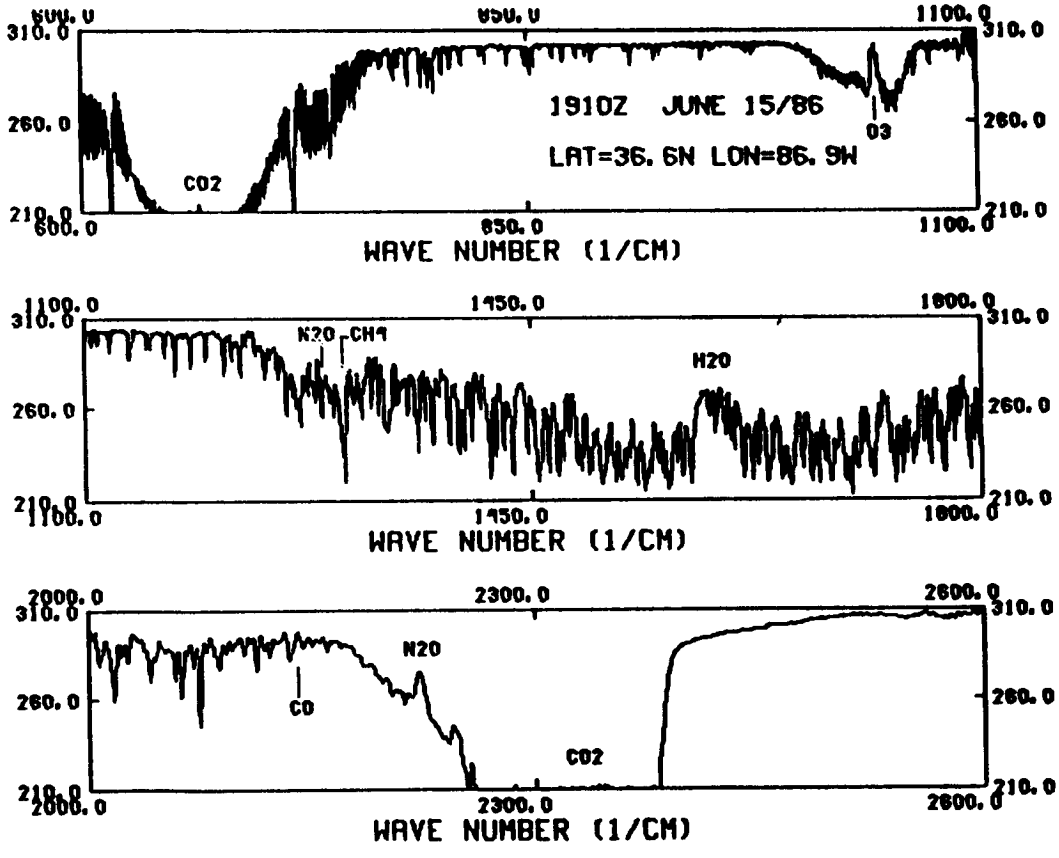


Fig. 2.3-10. HIS data for 15 June 1986 at 1910 GMT. (Top) Band 1: 600 to 1100 cm^{-1}, (Middle) Band 2: 1100 to 1800 cm^{-1}, (Bottom) Band 3: 2000 to 2600 cm^{-1}

References

Smith, W. L., 1987: (personal communication), Cooperative Institute for Meteorological Studies, Space Science and Engineering Center, University of Wisconsin, Madison, WI.

2.4 AIRCRAFT

2.4.1 South Dakota School of Mines and Technology T-28

The South Dakota School of Mines and Technology (SDSM&T) T-28 aircraft flew 14 research flights in which it made 74 mid-level storm penetrations over the SPACE region. The T-28 flights were directed from the CP-2 radar station. Radar reflectivity structure, Doppler and differential reflectivity data were used to select the storms and storm penetration tracks. The aircraft was equipped with instruments which collected kinematic, hydrometeor, and electrical field measurements. A complete description of the basic instrumentation is described in Johnson and Smith (1980). A Particle Measuring Systems (PMS) 2D-P probe and two electric field mills were installed for the experiment.

The static pressure and temperature values are each measured by two separate instruments. A Rosemount 1301-A-4-B is the primary static pressure sensing instrument. It is backed up with a Ball EX-210-B pressure sensor. The temperature measurements are made with a Rosemount and a NCAR reverse-flow sensors. The NCAR reverse-flow sensor is the preferred instrument for in-cloud measurements. A low-level tower fly-by was made on 24 July 1986 at the Redstone Arsenal. Preliminary results suggest that the T-28 pressure and temperature probes were working satisfactorily. The pressure measurements differed <0.5 mb, while the temperature measurements were with in 0.5°C.

The hydrometeor measurements by the T-28 fall into four particle size categories. The sensors are listed below:

1. Cloud droplets up to 30 micrometers in diameter with a J-W cloud liquid water concentration sensor and up to 45 micrometers with the PMS Forward Scattering Spectrometer Probe (FSSP).
2. Intermediate size particles from 30 to greater than 1000 micrometers with a PMS 2D-P optical array spectrometer.
3. Raindrops, graupel, and snowflakes from 1 mm to 5 mm with a continuous hydrometeor sampler.
4. Hailstones from 4 mm to 5 cm with a hail spectrometer.

Figure 2.4-1 shows the values of cloud liquid water concentration and hailstone concentration along with strong updraft and turbulence during a cloud penetration on 14 July 1986. The coincidence of these local maxima are indicative of particle growth during the penetration.

The electric field measurements were made on seven SPACE flights from 9 - 24 July 1986. The two electric field mills were mounted in a vertically opposed orientation, with one on the canopy and the other on the lower bay door. Electric field strengths up to -100 KV m^{-1} were measured on four of the flights.

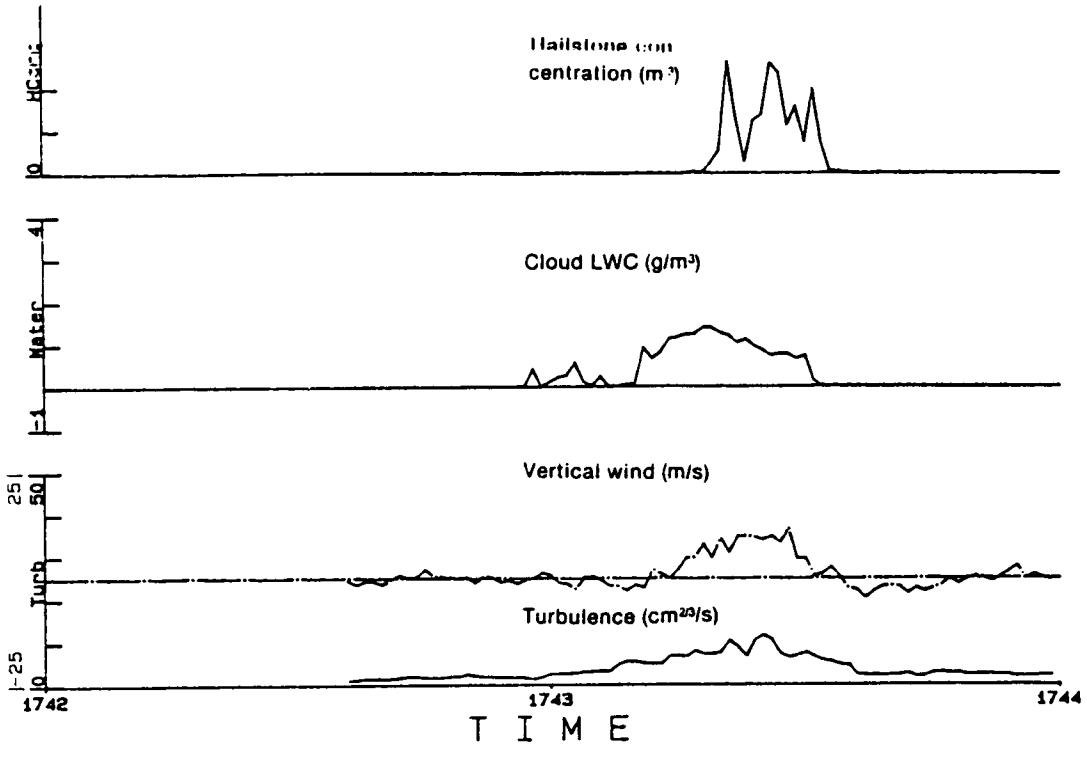


Fig. 2.4-1. Time plot of selected data from the sixth T-28 penetration on 14 July 1986. Hailstone concentrations are from the hail spectrometer and cloud Liquid Water Concentrations (LWC) from the FSSP. The time scale can be converted to an approximate distance scale using the nominal T-28 flight speed of 0.1 km s^{-1}.

References

Johnson, G. N., and P. L. Smith, Jr., 1980: Meteorological instrumentation system on the T-28 thunderstorm research aircraft. *Bull. Amer. Meteor. Soc.*, **61**, 972-979.

Musil, D. J. and P. L. Smith, Jr., 1986: *T-28 Data Acquisition During COHMEX 1986*, Institute of Atmospheric Sciences, South Dakota School of Mines and Technology, Report **SDSMT/IAS/R-86/08**.

2.4.2 University of North Dakota Cessna Citation

The University of North Dakota (UND) Cessna Citation carried PMS probes (FSSP, 2D-C, 1D-P) for measuring cloud and precipitation size spectra. An Inertial Navigation System/Gust Probe system was employed for wind a turbulence measurements. A Johnson-Williams hot-wire cloud liquid water sensor, an NCAR type reverse flow temperature sensor, a dewpoint hygrometer (cooled-mirror design), pressure transducers for measuring static and pitot pressures were also used during the flights. Side looking 16 mm time lapse cameras recorded the events during flight maneuvers. All measurements were digitally recorded by the Citation data system and displayed in real time aboard the aircraft. Data processing followed relatively standard procedures for the basic meteorological parameters and data from the PMS probes. Figure 2.4-2 is a representation of the PMS 2D-P hydrometeor particle data for a flight on 3 June 1986.

References

Poellot, Michael 1987: (personal communication), University of North Dakota, Grand Forks, ND.

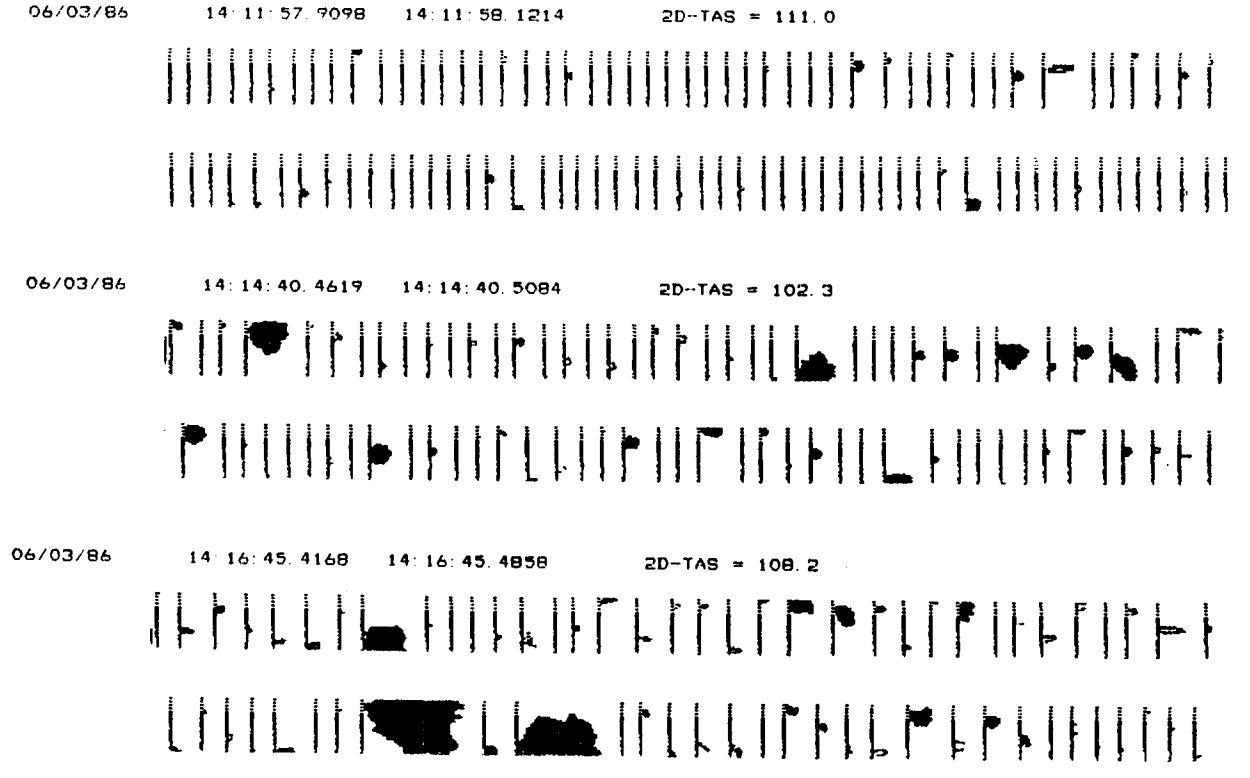


Fig. 2.4-2. PMS 2D-P hydrometeor particle data for a flight on 3 June 1986.

2.4.3 National Oceanic and Atmospheric Administration P-3

The National Oceanic and Atmospheric Administration (NOAA) P-3 aircraft carried a full complement of meteorological, cloud physics, radar and photographic instruments during the COHMEX experiment. Meteorological state variables measured include free air temperature, dewpoint temperature, static and dynamic pressure, and horizontal and vertical wind components. Surface radiation was recorded with a Office of Aircraft Operations (OAO) modified PRT-5 sensor. The cloud physics package records cloud droplet and hydrometeor spectra, liquid water content, and icing rate.

The P-3 is outfitted with a C-band PPI lower fuselage, 360° scan (horizontal) fan beam radar, and a Doppler X-band RHI tail, 360° scan (vertical) radar. Cloud structure is recorded with a 70 mm Hasselblad camera mounted in the belly of the fuselage and 16 mm time lapse cameras mounted on the nose and sides of the fuselage.

Figure 2.4-3 is a plot of an aircraft flight track with accompanying measured wind velocities. Figure 2.4-4 is a temperature and dewpoint time series graph during the same flight. These plots were produced on board the aircraft in real time.

References

NOAA/OAO MIST Operations Plan, 1986: NOAA Office of Aircraft Operations, Miami, FL

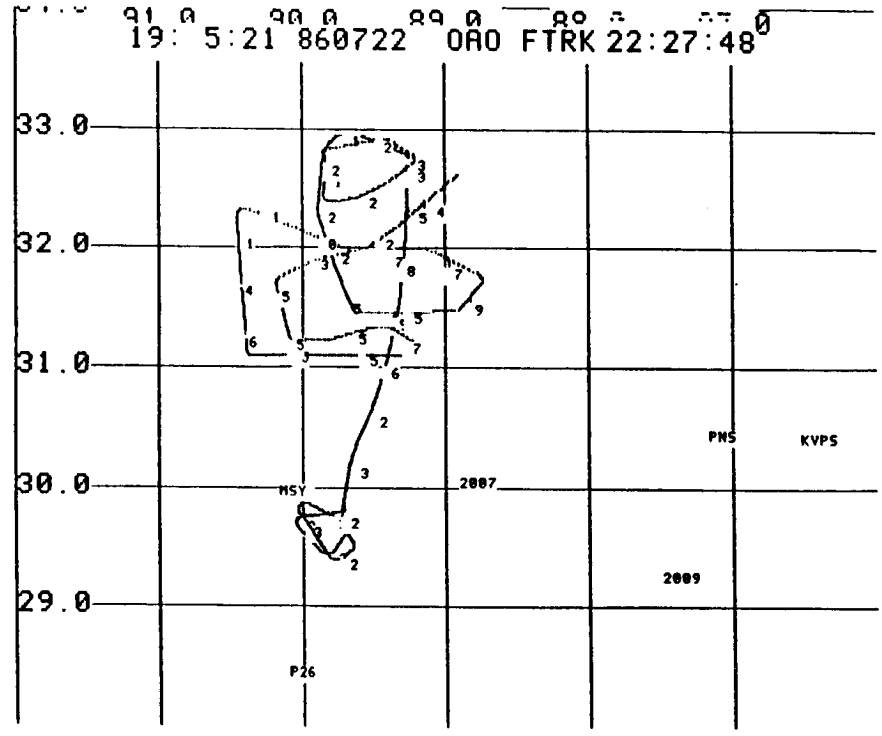


Fig. 2.4-3. Flight track of the P-3 on 22 July 1986 over southern Mississippi and Alabama, and the Gulf of Mexico. Numbers along the flight track are wind velocities (m s^{-1}).

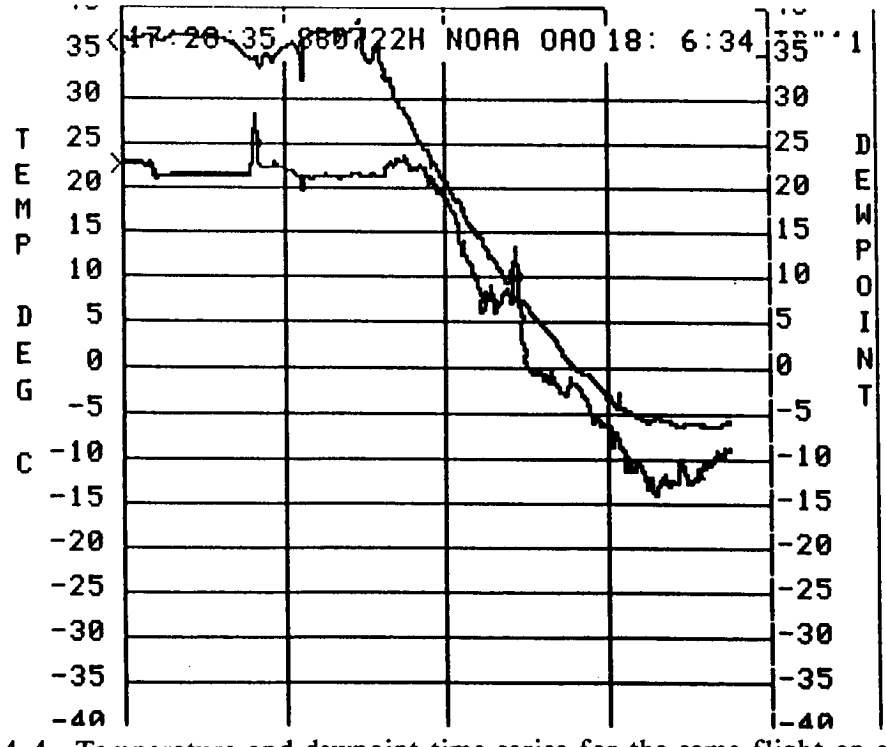


Fig. 2.4-4. Temperature and dewpoint time series for the same flight on as in Fig. 2-4-3.

2.4.4 National Oceanic and Atmospheric Administration Cessna T207

The importance of the merger and intersection of thunderstorm produced outflow boundaries (arc clouds) with other convective lines and boundaries in triggering deep convection has been discussed by Purdom (1979a, 1979b). He concluded that:

1. Thunderstorm outflow boundaries can maintain their identity as arc clouds for several hours after the convective array that produced them has dissipated.

2. The development of deep convection is favored in regions where the arc cloud merges with a cumulus region or where it intersects another boundary.

3. As the convective regime evolves through the course of the day, and much of the cumulus field dissipates, most of the new thunderstorms develop at the boundary intersection points.

The Cessna T207 penetrated the arc clouds in clear air and below the cumulus congestus cloud base in order to directly measure the convective scale interactions. The NOAA Cessna T207 has been outfitted with instrumentation for the direct measurement of the three-dimensional velocity field, temperature, dewpoint, pressure, atmospheric gases and particulates. The gust velocity (u', v', w', w) measurement system has been designed to be independent of the aircraft sensitivity to atmospheric motions and/or pilot induced motions. An on-board doppler wind system provides accurate measurements of ground speed and aircraft drift angle. Combining these data with the aircraft heading and true airspeed, provide mean (averaged every 5 sec) horizontal wind components (u, v). The dewpoint and total temperature are continuously recorded at a sampling rate of 0.04 sec.

References

Purdom, J. F. W., 1979a: The developments and evolution of deep convection. *Preprints 11th Conference on Severe Local Storms*, Kansas City, MO, Amer. Meteor. Soc., Boston, MA 143-150.

Purdom, J. F. W., 1979b: A new role for high resolution satellite imagery in convective cloud weather modification projects. *Preprints 7th Conference on Inadvertent and Planned Weather Modification*, Amer. Meteor. Soc., Boston, MA, 100.

Sinclair, P. C., and J. F. W. Purdom, 1983: Shuttle recovery requirements and the development of arc lines from thunderstorm outflows. *Preprints 9th Conference on Aerospace and Aeronautical Meteorology*, Amer. Meteor. Soc., Boston, MA 287-292.

2.5 SATELLITE SYSTEMS

There was one geostationary (GOES Central) and four polar orbiting (DMSP-F6, DMSP-F7, NOAA-9, Nimbus-7) satellites which collected data over the SPACE region.

2.5.1 GOES Central

The Geostationary Operational Environmental Satellite (GOES) Central satellite provided visible and infrared imagery on the hour and half past the hour. However, at 0530, 1130, 1730, and 2330 GMT the infrared images were replaced with a 6.7 micrometer water vapor image. On some days the GOES satellite was placed in the Rapid Interval Scan Operations Plan (RISOP) mode. While in RISOP, visible and infrared images of the continental United States were taken, in five minute intervals, between 14 and 29 and between 44 and 59 minutes past the hour.

In addition to the visible and infrared images, VISSR Atmospheric Sounder (VAS) images were collected on many days throughout the experiment. VAS images occur at 15 and 45 minutes past the hour. Three VAS wavelengths, the 6.7 micrometer mid-level water vapor (channel 10), the 11.2 micrometer atmospheric window (channel 8) and 12.7 micrometer low-level water vapor (channel 7) images were archived at MSFC. The precipitable water and lifted index VAS products derived from the VAS soundings are stored at the University of Wisconsin-Madison (UW-M) Space Science and Engineering Center (SSEC).

The 2 km resolution GOES visible and infrared images (center point 35° N and 87° W) were archived at MSFC. Some of the 1 km visible images, and 4 km visible and infrared images were archived at MSFC, but a complete set of imagery at these resolutions must be obtained from the University of Wisconsin-Madison SSEC. *Please note: The GOES satellite bar graphs on the daily data inventory sheets (section 3.2) only indicate the visible, infrared, RISOP and VAS images presently archived at MSFC. Additional images will be added to the archive at a later date.*

Video tape (VHS) movies comprised of visible and infrared images were generated for the daily COHMEX weather briefings. These movies contain loops of the visible and infrared images at various loop speeds. The tapes are stored at MSFC and are available for distribution.

2.5.2 Defense Meteorological Satellite Program (DMSP)

The data from the Defense Meteorological Satellite Program (DMSP) polar orbiting satellites (F6 and F7) were not stored on magnetic media. The DMSP images are stored in photographic form at the National Snow & Ice Center at the University of Colorado.

Tables 2.5-1 and 2.5-2 list the revolution numbers and times of all satellite orbits, F6 and F7 respectively, which view the SPACE region.

Table 2.5-1 Revolution numbers and times for DMSP F6

VEHID F6

REV	DATE	Z TIME	REV	DATE	Z TIME	REV	DATE	Z TIME	REV	DATE	Z TIME
17703D	5-19-86	5/48	17710A	5-19-86	17/13	17717D	5-20-86	5/27	17718D	5-20-86	7/ 8
17724A	5-20-86	16/51	17725A	5-20-86	18/33	17732D	5-21-86	6/47	17739A	5-21-86	18/11
17746D	5-22-86	6/26	17753A	5-22-86	17/50	17760D	5-23-86	6/ 4	17767A	5-23-86	17/28
17774D	5-24-86	5/43	17775D	5-24-86	7/24	17781A	5-24-86	17/ 7	17789D	5-25-86	7/ 3
17795A	5-25-86	16/46	17796A	5-25-86	18/27	17803D	5-26-86	6/41	17810A	5-26-86	18/ 6
17817D	5-27-86	6/20	17824A	5-27-86	17/44	17831D	5-28-86	5/59	17838A	5-28-86	17/23
17845D	5-29-86	5/37	17846D	5-29-86	7/19	17852A	5-29-86	17/ 2	17853A	5-29-86	18/43
17860D	5-30-86	6/57	17866A	5-30-86	16/40	17867A	5-30-86	18/21	17874D	5-31-86	6/36
17881A	5-31-86	18/ 0	17888D	6- 1-86	6/15	17895A	6- 1-86	17/39	17902D	6- 2-86	5/53
17909A	6- 2-86	17/17	17916D	6- 3-86	5/32	17917D	6- 3-86	7/13	17923A	6- 3-86	16/56
17924A	6- 3-86	18/37	17931D	6- 4-86	6/52	17938A	6- 4-86	18/16	17945D	6- 5-86	6/30
17952A	6- 5-86	17/55	17959D	6- 6-86	6/ 9	17966A	6- 6-86	17/33	17973D	6- 7-86	5/48
17974D	6- 7-86	7/29	17980A	6- 7-86	17/12	17987D	6- 8-86	5/26	17988D	6- 8-86	7/ 8
17994A	6- 8-86	16/50	17995A	6- 8-86	18/32	18002D	6- 9-86	6/46	18009A	6- 9-86	18/10
18016D	6-10-86	6/25	18023A	6-10-86	17/49	18030D	6-11-86	6/ 3	18037A	6-11-86	17/28
18044D	6-12-86	5/42	18045D	6-12-86	7/23	18051A	6-12-86	17/ 6	18052A	6-12-86	18/48
18059D	6-13-86	7/ 2	18065A	6-13-86	16/45	18066A	6-13-86	18/26	18073D	6-14-86	6/41
18080A	6-14-86	18/ 5	18087D	6-15-86	6/19	18094A	6-15-86	17/44	18101D	6-16-86	5/58
18108A	6-16-86	17/22	18115D	6-17-86	5/37	18116D	6-17-86	7/18	18122A	6-17-86	17/ 1
18123A	6-17-86	18/42	18130D	6-18-86	6/57	18136A	6-18-86	16/39	18137A	6-18-86	18/21
18144D	6-19-86	6/35	18151A	6-19-86	17/59	18158D	6-20-86	6/14	18165A	6-20-86	17/38
18172D	6-21-86	5/52	18173D	6-21-86	7/34	18179A	6-21-86	17/17	18186D	6-22-86	5/31
18187D	6-22-86	7/12	18193A	6-22-86	16/55	18194A	6-22-86	18/37	18201D	6-23-86	6/51
18208A	6-23-86	18/15	18215D	6-24-86	6/30	18222A	6-24-86	17/54	18229D	6-25-86	6/ 8
18236A	6-25-86	17/32	18243D	6-26-86	5/47	18244D	6-26-86	7/28	18250A	6-26-86	17/11
18258D	6-27-86	7/ 7	18264A	6-27-86	16/50	18265A	6-27-86	18/31	18272D	6-28-86	6/45
18279A	6-28-86	18/10	18286D	6-29-86	6/24	18293A	6-29-86	17/48	18300D	6-30-86	6/ 3
18307A	6-30-86	17/27	18314D	7- 1-86	5/41	18315D	7- 1-86	7/23	18321A	7- 1-86	17/ 6
18322A	7- 1-86	18/47	18329D	7- 2-86	7/ 1	18335A	7- 2-86	16/44	18336A	7- 2-86	18/25
18343D	7- 3-86	6/40	18350A	7- 3-86	18/ 4	18357D	7- 4-86	6/19	18364A	7- 4-86	17/43
18371D	7- 5-86	5/57	18378A	7- 5-86	17/21	18385D	7- 6-86	5/36	18386D	7- 6-86	7/17
18392A	7- 6-86	17/ 0	18393A	7- 6-86	18/41	18400D	7- 7-86	6/56	18407A	7- 7-86	18/20
18414D	7- 8-86	6/34	18421A	7- 8-86	17/59	18428D	7- 9-86	6/13	18435A	7- 9-86	17/37
18442D	7-10-86	5/52	18443D	7-10-86	7/33	18449A	7-10-86	17/16	18456D	7-11-86	5/30
18457D	7-11-86	7/12	18463A	7-11-86	16/54	18464A	7-11-86	18/36	18471D	7-12-86	6/50
18478A	7-12-86	18/14	18485D	7-13-86	6/29	18492A	7-13-86	17/53	18499D	7-14-86	6/ 7
18506A	7-14-86	17/32	18513D	7-15-86	5/46	18514D	7-15-86	7/27	18520A	7-15-86	17/10
18521A	7-15-86	18/52	18528D	7-16-86	7/ 6	18534A	7-16-86	16/49	18535A	7-16-86	18/30
18542D	7-17-86	6/45	18549A	7-17-86	18/ 9	18556D	7-18-86	6/23	18563A	7-18-86	17/48
18570D	7-19-86	6/ 2	18577A	7-19-86	17/26	18584D	7-20-86	5/41	18585D	7-20-86	7/22
18591A	7-20-86	17/ 5	18592A	7-20-86	18/46	18599D	7-21-86	7/ 1	18605A	7-21-86	16/43
18606A	7-21-86	18/25	18613D	7-22-86	6/39	18620A	7-22-86	18/ 3	18627D	7-23-86	6/18
18634A	7-23-86	17/42	18641D	7-24-86	5/56	18642D	7-24-86	7/38	18649A	7-24-86	17/21
18655D	7-25-86	5/35	18656D	7-25-86	7/16	18662A	7-25-86	16/59	18663A	7-25-86	18/41
18670D	7-26-86	6/55	18677A	7-26-86	18/19	18684D	7-27-86	6/34	18691A	7-27-86	17/58
18698D	7-28-86	6/12	18705A	7-28-86	17/36	18712D	7-29-86	5/51	18713D	7-29-86	7/32
18719A	7-29-86	17/15	18727D	7-30-86	7/11	18733A	7-30-86	16/54	18734A	7-30-86	18/35
18741D	7-31-86	6/49	18748A	7-31-86	18/14						

Table 2.5-2 Revolution numbers and times for DMSP F7

VEHID F7

REV	DATE	Z TIME	REV	DATE	Z TIME	REV	DATE	Z TIME	REV	DATE	Z TIME
12905D	5-14-86	9/ 7	12906D	5-14-86	10/48	12912A	5-14-86	20/31	12913A	5-14-86	22/13
12920D	5-15-86	10/28	12926A	5-15-86	20/11	12927A	5-15-86	21/52	12934D	5-16-86	10/ 7
12941A	5-16-86	21/32	12948D	5-17-86	9/47	12955A	5-17-86	21/11	12962D	5-18-86	9/26
12963D	5-18-86	11/ 8	12969A	5-18-86	20/51	12976D	5-19-86	9/ 6	12977D	5-19-86	10/47
12983A	5-19-86	20/31	12984A	5-19-86	22/12	12991D	5-20-86	10/27	12998A	5-20-86	21/51
13005D	5-21-86	10/ 6	13012A	5-21-86	21/31	13019D	5-22-86	9/46	13026A	5-22-86	21/11
13033D	5-23-86	9/26	13034D	5-23-86	11/ 7	13040A	5-23-86	20/50	13047D	5-24-86	9/ 5
13048D	5-24-86	10/47	13054A	5-24-86	20/30	13055A	5-24-86	22/11	13062D	5-25-86	10/26
13069A	5-25-86	21/51	13076D	5-26-86	10/ 6	13083A	5-26-86	21/30	13090D	5-27-86	9/45
13097A	5-27-86	21/10	13104D	5-28-86	9/25	13105D	5-28-86	11/ 6	13111A	5-28-86	20/49
13118D	5-29-86	9/ 4	13119D	5-29-86	10/46	13125A	5-29-86	20/29	13126A	5-29-86	22/10
13133D	5-30-86	10/25	13140A	5-30-86	21/50	13147D	5-31-86	10/ 5	13154A	5-31-86	21/30
13161D	6- 1-86	9/45	13168A	6- 1-86	21/ 9	13175D	6- 2-86	9/24	13176D	6- 2-86	11/ 5
13182A	6- 2-86	20/49	13189D	6- 3-86	9/ 4	13190D	6- 3-86	10/45	13196A	6- 3-86	20/28
13197A	6- 3-86	22/10	13204D	6- 4-86	10/25	13211A	6- 4-86	21/49	13218D	6- 5-86	10/ 4
13225A	6- 5-86	21/29	13232D	6- 6-86	9/44	13239A	6- 6-86	21/ 8	13246D	6- 7-86	9/23
13247D	6- 7-86	11/ 5	13253A	6- 7-86	20/48	13260D	6- 8-86	9/ 3	13261D	6- 8-86	10/44
13267A	6- 8-86	20/28	13268A	6- 8-86	22/ 9	13275D	6- 9-86	10/24	13282A	6- 9-86	21/49
13289D	6-10-86	10/ 3	13296A	6-10-86	21/28	13303D	6-11-86	9/43	13310A	6-11-86	21/ 8
13317D	6-12-86	9/23	13318D	6-12-86	11/ 4	13324A	6-12-86	20/47	13331D	6-13-86	9/ 2
13332D	6-13-86	10/44	13338A	6-13-86	20/27	13339A	6-13-86	22/ 8	13346D	6-14-86	10/23
13353A	6-14-86	21/48	13360D	6-15-86	10/ 3	13367A	6-15-86	21/27	13374D	6-16-86	9/42
13381A	6-16-86	21/ 7	13388D	6-17-86	9/22	13389D	6-17-86	11/ 3	13395A	6-17-86	20/47
13402D	6-18-86	9/ 1	13403D	6-18-86	10/43	13409A	6-18-86	20/26	13410A	6-18-86	22/ 8
13417D	6-19-86	10/22	13424A	6-19-86	21/47	13431D	6-20-86	10/ 2	13438A	6-20-86	21/27
13445D	6-21-86	9/42	13452A	6-21-86	21/ 6	13459D	6-22-86	9/21	13460D	6-22-86	11/ 3
13466A	6-22-86	20/46	13473D	6-23-86	9/ 1	13474D	6-23-86	10/42	13480A	6-23-86	20/25
13481A	6-23-86	22/ 7	13488D	6-24-86	10/22	13495A	6-24-86	21/46	13502D	6-25-86	10/ 1
13509A	6-25-86	21/26	13516D	6-26-86	9/41	13523A	6-26-86	21/ 6	13530D	6-27-86	9/20
13531D	6-27-86	11/ 2	13537A	6-27-86	20/45	13544D	6-28-86	9/ 0	13545D	6-28-86	10/41
13551A	6-28-86	20/25	13552A	6-28-86	22/ 6	13559D	6-29-86	10/21	13566A	6-29-86	21/46
13573D	6-30-86	10/ 1	13580A	6-30-86	21/25	13587D	7- 1-86	9/40	13594A	7- 1-86	21/ 5
13601D	7- 2-86	9/20	13602D	7- 2-86	11/ 1	13608A	7- 2-86	20/44	13615D	7- 3-86	8/59
13616D	7- 3-86	10/41	13622A	7- 3-86	20/24	13623A	7- 3-86	22/ 5	13630D	7- 4-86	10/20
13637A	7- 4-86	21/45	13644D	7- 5-86	10/ 0	13651A	7- 5-86	21/24	13658D	7- 6-86	9/39
13665A	7- 6-86	21/ 4	13672D	7- 7-86	9/19	13673D	7- 7-86	11/ 0	13679A	7- 7-86	20/44
13686D	7- 8-86	8/59	13687D	7- 8-86	10/40	13693A	7- 8-86	20/23	13694A	7- 8-86	22/ 5
13701D	7- 9-86	10/20	13708A	7- 9-86	21/44	13715D	7-10-86	9/59	13722A	7-10-86	21/24
13729D	7-11-86	9/39	13736A	7-11-86	21/ 3	13743D	7-12-86	9/18	13744D	7-12-86	11/ 0
13750A	7-12-86	20/43	13758D	7-13-86	10/39	13764A	7-13-86	20/22	13765A	7-13-86	22/ 4
13772D	7-14-86	10/19	13779A	7-14-86	21/43	13786D	7-15-86	9/58	13793A	7-15-86	21/23
13800D	7-16-86	9/38	13807A	7-16-86	21/ 3	13814D	7-17-86	9/18	13815D	7-17-86	10/59
13821A	7-17-86	20/42	13829D	7-18-86	10/38	13835A	7-18-86	20/22	13836A	7-18-86	22/ 3
13843D	7-19-86	10/18	13850A	7-19-86	21/43	13857D	7-20-86	9/58	13864A	7-20-86	21/22
13871D	7-21-86	9/37	13878A	7-21-86	21/ 2	13885D	7-22-86	9/17	13886D	7-22-86	10/58
13892A	7-22-86	20/41	13900D	7-23-86	10/38	13906A	7-23-86	20/21	13907A	7-23-86	22/ 2
13914D	7-24-86	10/17	13921A	7-24-86	21/42	13928D	7-25-86	9/57	13935A	7-25-86	21/22
13942D	7-26-86	9/36	13949A	7-26-86	21/ 1	13956D	7-27-86	9/16	13957D	7-27-86	10/57
13963A	7-27-86	20/41	13971D	7-28-86	10/37	13977A	7-28-86	20/20	13978A	7-28-86	22/ 2
13985D	7-29-86	10/17	13992A	7-29-86	21/41	13999D	7-30-86	9/56	14006A	7-30-86	21/21
14013D	7-31-86	9/36	14020A	7-31-86	21/ 0						

2.5.3 Nimbus 7

The Nimbus 7 satellite has a 955 km sun-synchronous polar orbit with a equator crossing at noon (ascending) and midnight (descending) local time. The satellite carries a variety of instruments many of which are no longer operational. Two instruments which functioned during SPACE and have applicability to the SPACE experiment are the Solar Backscatter UltraViolet/Total Ozone Mapping Spectrometer (SBUV/TOMS) and the Scanning Multichannel Microwave Radiometer (SMMR). The SBUV/TOMS operated full time daily, while the SMMR was turned on every other day. The times listed in the daily data inventory sheets indicate the orbital times when the satellite passed closest to the SPACE region.

References

Chen, H. S., 1985: *Space Remote Sensing Systems An Introduction*, Academic Press, 257pp.

2.5.4 NOAA-9

The NOAA-9 satellite operates in a near-polar circular sun-synchronous orbit with a nominal altitude of about 870 km and a inclination angle near 98°. The satellite crosses the equator at 3:00 p.m. local time in the ascending orbit. The primary sensor on the NOAA-9 is the Advanced Very High Resolution Radiometer (AVHRR). The AVHRR is a cross-track scanning system with five spectral channels in the visible, near-infrared, and infrared spectra. The spectral band widths are listed in Table 2.5-3. The instantaneous field of view (IFOV) of each sensor is approximately 1.4 milliradians thereby producing a resolution of 1.1 km at nominal altitude.

Table 2.5-3 AVHRR Spectral Band Widths

Channel #	Band Width (micrometers)
1	0.58 - 0.68
2	0.72 - 1.10
3	3.55 - 3.93
4	10.30 - 11.30
5	11.50 - 12.50

The TIROS Operational Vertical Sounder (TOVS) is also carried aboard the NOAA-9 satellite. The TOVS units consists of four sensors: the High Resolution Infrared Radiation Sounder/2 (HIRS/2), the Microwave Sounding Unit (MSU), the Stratospheric Sounding Unit (SSU), and the Solar Backscatter UltraViolet Radiometer/2 (SBUV/2).

The HIRS/2 measures the incident radiation in the infrared region of the spectrum including both the longwave (15 micrometers) and shortwave (4.3 micrometers). The MSU is a passive scanning microwave spectrometer. The MSU has four channels in the 5.5 micrometer oxygen region. The four channels are centered on 50.3, 53.74, 54.96 and 57.95 GHz respectively, with a 200 MHz bandwidth. The SSU is a step-scanned far-infrared spectrometer in the 15 micrometer carbon dioxide absorption band region. The instrument measures radiation emitted from carbon dioxide at the top of the Earth's atmosphere. Finally the SBUV/2 determines the total ozone and its vertical concentration distribution above the ozone maximum by measuring the scattered solar radiance. The SBUV/2 uses 12 narrow wavelength bands in the 250 to 340 nm range.

References

Chen, H. S., 1985: *Space Remote Sensing Systems An Introduction*, Academic Press, 257pp.

Kidwell, K. B., 1986: *NOAA Polar Orbiter Data Users Guide*, NOAA/NESDIS/NCDC Satellite Data Services Division, Washington, D.C.

2.6 SURFACE SYSTEMS

Surface networks utilized for the field program included various automated mesonet systems, the western TVA raingage network, the NASA Lightning Location and Protection (LLP) lightning detection network, the National Severe Storm Laboratory (NSSL) mobile laboratory, and various private and agency cooperative meteorological observer networks. These measurements consisted of both existing and special deployed stations. A unique aspect of COHMEX provided the highest density of automated mesonet stations assembled for a field program.

2.6.1 Automated Mesonet Systems

The automated surface observation systems (89 stations) were operational on a 24-h a day basis. They included the NCAR second generation Portable Automated Mesonet (PAM II) network (Pike et al., 1983), the FAA Automated Mesonet System (FAMS) (Wolfson, M.M., 1987), and the NASA Mesonet System (NAMS). Figure 2.6-1 shows the distributions of these stations in relation to the radars. The PAM II and FAMS networks provided 1-min average data of wind velocity, temperature, dewpoint, pressure, and precipitation (nine PAM II stations also recorded direct solar insolation). The NAMS network provided 5-h averages of wind velocity, peak wind gust, temperature, dewpoint, precipitation, and direct, diffuse, and reflected solar insolation. All data are archived in Common Mesonet Format (CMF) developed by NCAR (NCAR 1985) for uniformity of mesonet data. Details of data format and file structure are available from NCAR.

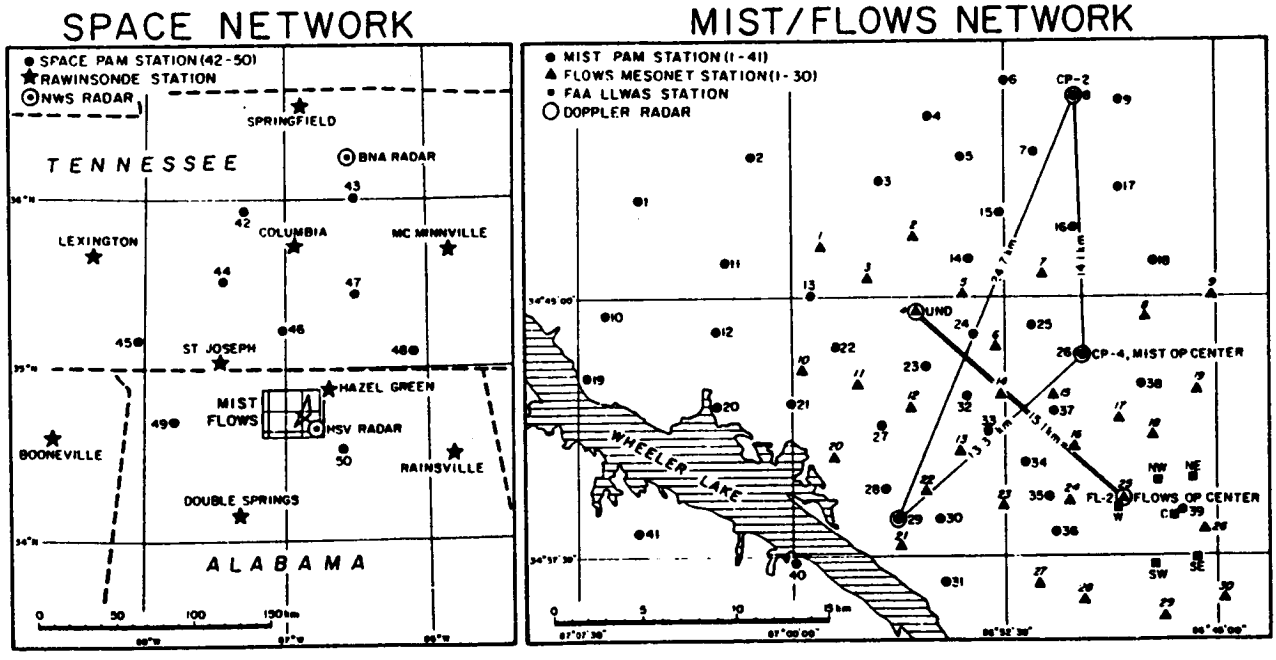


Fig. 2.6-1 (Left) Locations of the SPACE network surface stations. (Right) Locations of the MIST and Flows surface stations.

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Pike, J. M., Brock, F. V., and S. R. Semmer, 1983: Integrated Sensors for PAM II. *Proceedings of the Fifth Symposium on Meteorological Observations and Instrumentation*, Toronto, Ont., Canada. April 11-15, 1983.

Wolfson, M.M., 1987: The FLOWS Automatic Weather Station Network. *Proceedings of the Sixth Symposium on Meteorological Observations and Instrumentation*, New Orleans, Louisiana. January 12-16, 1987.

Common Mesonet Format Documentation, National Center for Atmospheric Research, Boulder, Colorado. December 1985.

2.6.2 Tennessee Valley Authority Automated Raingage Network

Seventy-two existing Tennessee Valley Authority (TVA) automatic raingage stations collected precipitation data during the field program. Of these 72 gages, 62 were the standard TVA telephone linked Automated Data Acquisition System (ADAS) gage 6-h measurements, and 10 were Very High Frequency (VHF) radio gage 2-h measurements. Figure 2.6-2 shows the TVA automatic raingage network distribution in relation to the NAMS network. Daily 24-h plots of TVA ADAS raingage rainfall amounts are presented in Section 3.2.

The ADAS gages are weighing raingages connected to a telephone modem. The ADAS gages were dialed by a TVA computer at 6-h intervals beginning at 0500 GMT (0000 CDT). The computer recorded the amount of water in the bucket. The 6-h rainfall amounts were calculated as difference in consecutive 6-h readings. The 24-h rainfall amounts are the greater of the summation of the 6-h readings or the difference 0500 GMT reading for consecutive days. Some data recording problems existed due to faulty circuit boards, noisy telephone lines, and gage malfunctions. However, in general the ADAS gages operated satisfactorily.

The ADAS gages were equipped with a modified data recording circuit board. The gage operated simultaneously as a ADAS 6-h gage and as a TVA 5-min raingage. The TVA 5-min gages powered up every five minutes, read the raingage, and powered down. The reading was compared to the previous 5-min reading. If the the new reading exceeded the previous reading by at least 0.75 mm, then the gage reading and time stamp was stored in the TVA 5-min gage memory board (the memory was dumped at a later time). The gage could only remember the previous 5-min reading. Therefore, consecutive 5-min rainfall amounts of 0.50 mm were never recorded as rainfall, since the 0.75 mm threshold was never exceeded. Consequently, the TVA 5-min gages grossly underestimated light rainfall. The TVA 5-min recording gages suffered from faulty circuit boards, noisy telephone lines, gage malfunctions, and other recording problems. Over half of this data were lost due to the above problems. Despite the lost data, this data set does show some interesting rainfall rates and amounts associated with thunderstorm passages.

2.6.3 Lightning Detection Network

The NASA 4-station Lightning Location and Protection (LLP) lightning detection network recorded both positive and negative cloud to ground lightning flashes over portions of an eight state area. The system ran continuously during the field program, and the data were archived at MSFC. Calibration factors have been applied to the data to correct any antenna offset errors. However, these corrections were not applied to the twenty-four hour plots of lightning density as presented in Section 3.2.

The lightning detection and location system at MSFC uses four radio direction finding systems linked to a central computer to determine the location, time, number of component return strokes, polarity, and signal intensity of lightning discharges to ground. The basic system is manufactured by Lightning, Location, and Protection, Incorporated. In post analysis, estimates of the peak return stroke current, semi-major and semi-minor axis of the error ellipse, equivalent circular error radius, and area of the error ellipse are computed. The locations of the four direction finders are shown in Table 2.6-1 below.

Table 2.6-1. Location of LLP direction finders

Direction Finder	Latitude	Longitude
1	34.64916	86.66917
2	35.39916	86.07694
3	35.83750	87.44386
4	34.71667	87.88167

Figure 2.6-3 shows the average diurnal variation of lightning activity during the months of June and July, 1986. The large peak between 1600 and 1700 GMT lags solar noon by 3-5 hours. This diurnal lightning peak has been observed by others in Florida (e.g., Maier, et al, 1984), and in the Western U. S. (e.g., Reap, 1986). The semidiurnal lightning peak in the morning at 0700 local coincides with the time of maximum convergence associated with the S pressure wave (Wallace, 1975; Brier and Simpson, 1969). This morning peak occurs on more than 30 of the 60 days in the field program. In addition, when convection is already present in the early morning hours, we also observe an increase in lightning rates (storm intensification) at 0700 local time.

Figure 2.6-4a and b depict the cloud-to-ground lightning discharge recorded by the LLP network during June and July 1986. The figures include both positive and total discharges (positive and negative).

References

Brier, G. W., and J. Simpson, 1969. Tropical cloudiness and rainfall related to pressure and tidal variations, *Q. J. Roy. Meteor. Soc.*, **95**, 120-147.

Maier, L. M., E. P. Krider, and M. W. Maier, 1984. Average diurnal variation of summer lightning over the Florida Peninsula, *Mon. Wea. Rev.*, **112**, 1134-1140.

Reap, R. M., 1986. Evaluation of cloud-to-ground lightning data from the Western United States for the 1983-84 Summer Seasons, *J. Clim. Appl. Meteor.*, **25**, 785-799.

Wallace, J. M., 1975. Diurnal variations in precipitation and thunderstorm frequency over the conterminous United States, *Mon. Wea. Rev.*, **103**, 406-419.

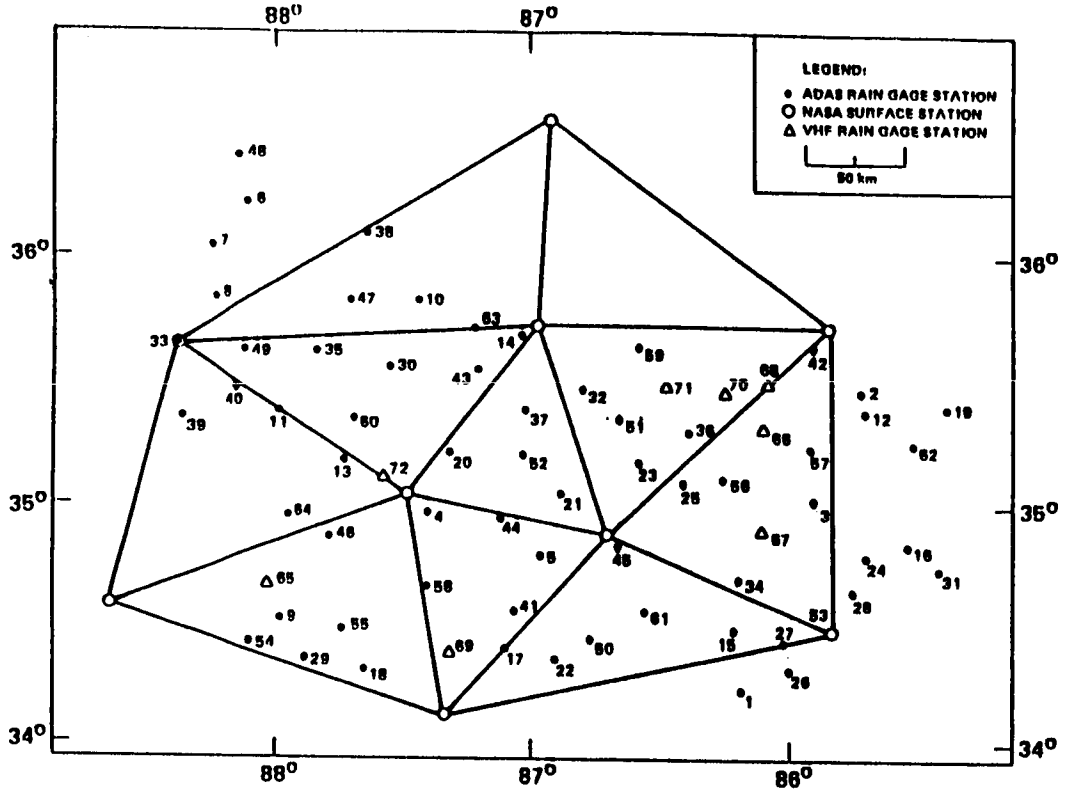


Fig. 2.6-2. TVA automatic raingage network and the NAMS network.

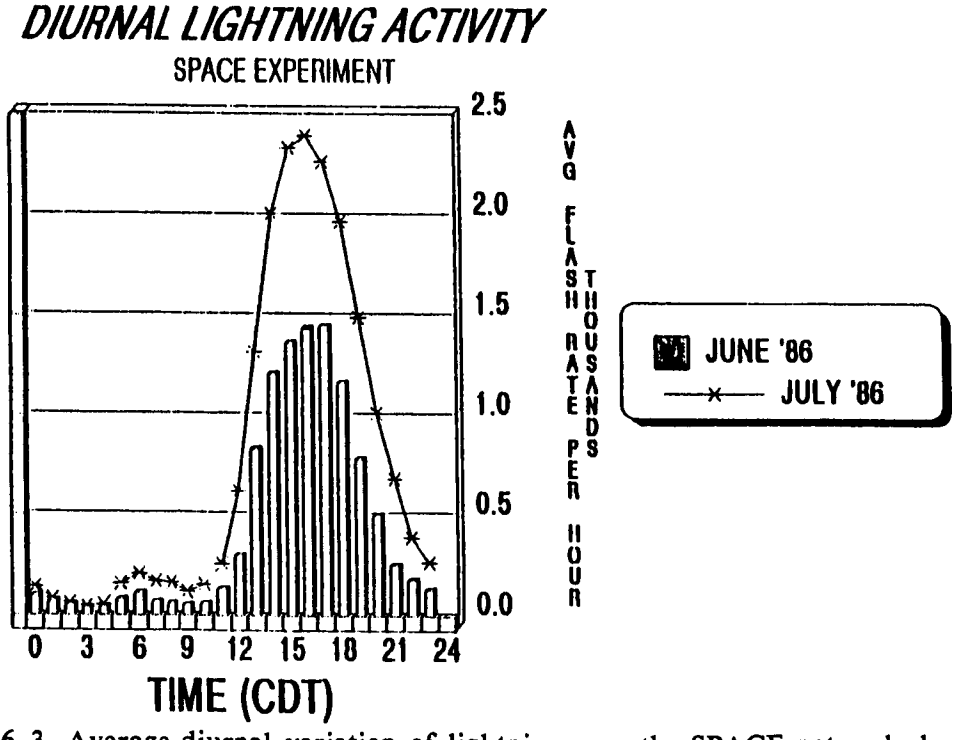


Fig. 2.6-3. Average diurnal variation of lightning over the SPACE network during

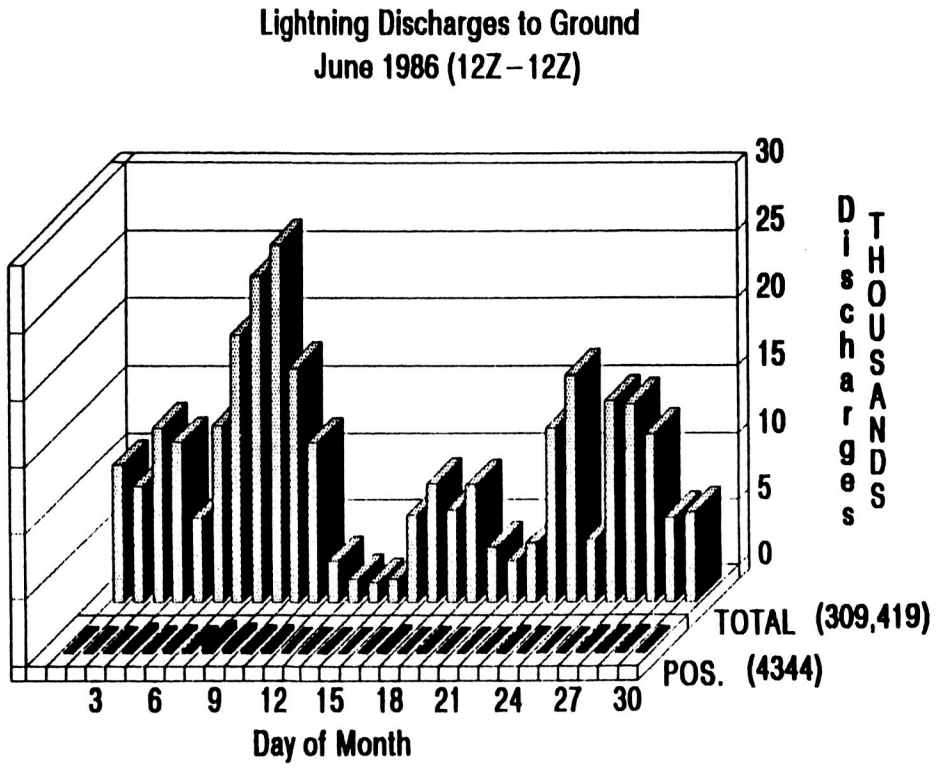


Fig. 2.6-4a. Cloud-to-ground lightning discharge recorded by the LLP network during June 1986.

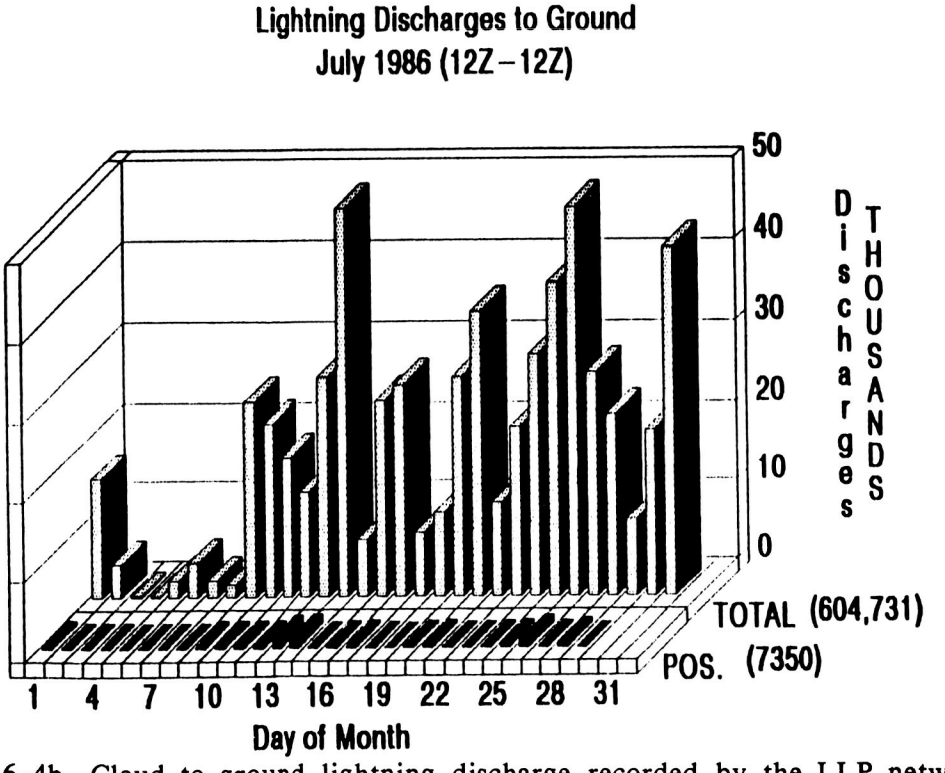


Fig. 2.6-4b. Cloud-to-ground lightning discharge recorded by the LLP network during July 1986.

2.6.4 Mobile Laboratory

The Storm Electricity Group of NSSL operated a mobile van laboratory (Rust, 1986) over portions of the SPACE network during the field program, which made quantitative measurements in the storm environment. It was equipped with an electric field mill sensor to record the electrostatic component of the electric field from lightning and the higher frequency components of the radiated wave form, an 8-channel optical detector to measure return stroke velocity from cloud-to-ground return stroke channels, and two television video recording systems: one television providing high contrast black and white, the other in color with an external microphone for recording thunder. Both television systems have audio tracks recording comments of crew members with encoded time on their images. The mobile laboratory also carried an IRIG-B time code generator synchronized to international time-broadcast station WWV and a Loran-C navigation receiver and data recording to provide location. In addition, the mobile laboratory was modified for SPACE with a receiver and recorders for the telemetry from the balloon borne electric field meter, the incorporation of a deployable Maxwell current sensor, and the University of Arizona wide band, transient optical detector for comparison with remote sensor measurements.

References

Rust, W.D., 1986: (personal communication), National Severe Storm Laboratory, Norman, Oklahoma.

2.6.5 Other Surface Systems

Data from other existing surface measurement stations in the SPACE network and surrounding area are included in the data base. The NWS Cooperative Observer network recorded 24-h totals of rainfall and temperature data. Some of these stations recorded 1-h precipitation amounts. TVA operated a network of private observers and hydro-station facilities that recorded 24-h rainfall totals. The Department of Energy, Army Corps of Engineers, and the U.S. Geological Survey all maintained various meteorological recording stations in the area. Certain Agricultural Extension offices recorded standard meteorological measurements as well as soil moisture and acid deposition observations.

3.0 METEOROLOGICAL CONDITIONS AND DATA INVENTORY

3.1 Synoptic Overview of the Field Program

The most prominent weather/climate feature during the June-July intense SPACE operational period was the drought that affected much of the Southeast (see Bergman et. al., 1986). During the June to July period, the drought was most significant over eastern Tennessee, the Carolinas, and northern Georgia. The portions of the SPACE mesonet over northern Alabama and south-central Tennessee received significantly more rainfall, although below normal conditions were experienced over most of this region. Despite the general drought conditions, a variety of synoptic weather and precipitating cloud systems were observed over the SPACE mesonet in June and July.

Some details on the general weather conditions observed at the Huntsville (HSV) Weather Service Office (WSO) during June and July are given in Fig. 3.1-1. Additional information derived from daily soundings (usually 1800 GMT) taken mainly from Redstone Arsenal (~20 km east-southeast of the HSV WSO) are given in Fig. 3.1-2 through Fig. 3.1-5. As depicted in these figures, several different synoptic regimes were experienced during the experimental program. The most unstable and moist periods, as indicated by low lifted index values and high precipitable water (Figs. 3.1-2a and b, and Figs. 3.1-3a and b, respectively) included 2-11 June, 24-29 June and much of July. The most stable and dry periods occurred during 12-16 June, 18-22 June, 3-5 July and 29-30 July. Stable periods were in general associated with development of upper-level ridges over or near the SPACE mesonet, and also with post cold frontal air masses. A total of seven cold frontal passages during the two-month period were observed on 2-3 June, 12 June, 17 June, 24 June, 2 July, 20 July and 29 July. The most significant cold frontal passages in terms of cooling and drying occurred on 12 June, 17 June and 2 July. Warm core anticyclone episodes over or near the SPACE mesonet were observed during the following time periods: 3-4 June, 13-15 June, 18-23 June, 26 June, 5-10 July, 16-20 July and 22-26 July.

Precipitable water values derived from Redstone Arsenal sounding were often greater than 40 mm. Average values during July were greater and more persistent than those of June, in accordance with climatology. It also appears that precipitable water values from the Nashville sounding site located 150 km to the north were lower by at least 10% on the average. Air mass stability characteristics displayed distinct trends during June, but were more consistent during July. Typical values of lifted index on active thunderstorm days were about -5, with a minimum of -9.5. A vertically integrated stability index, such as Convective Available Potential Energy (CAPE) displayed more daily variability (Fig 3.1-4a and b). Typical CAPE values on thunderstorm days were around 2000 J kg^{-1}. This value includes parcel sensible temperature excess only and does not consider virtual effects of water loading, which are large in moist environments. Bulk Richardson number calculations (Weisman and Klemp, 1984), obtained from the formula:

$$RI = CAPE / (0.5\ U^2),$$

also varied substantially (Fig. 3.1-5a and b) from day to day. These values were seldom less than 100, and often greater than 500. The wind shear (U) is the difference between the environmental wind speeds at low levels (500 m) and the density weighted average wind from the surface to 6 km. Figures 3.1-6a and b depict the wind shear for June and July 1986.

Vertical shear of the horizontal wind was most often weak, as shown in Fig. 3.1-7a and b. Wind shear was objectively determined, following Weisman and Klemp (1984), by computing the difference between the average wind vector within the lowest 500 m and the density-weighted wind vector over the lowest 6 km. This difference is defined herein as the shear vector magnitude U. Periods that experienced moderate wind shear (defined as a shear vector magnitude greater than 5 m s^{-1}) include 4 June, 9 June, 11-12 June, 17 June, 24 June, 1 July, 11-15 July and 28-31 July. It is noteworthy that these time periods encompass many of the intense thunderstorm days.

A brief description of thunderstorm/precipitation events is provided in Table 3.1-1. Specific details are given in the Daily Summaries in Section 3.2. Days that experienced widespread thunderstorm activity over the SPACE mesonet include 6 June, 11 June, 24 June, 28 June, 11 July, 13 July, 14 July, and 31 July. On many other days thunderstorms were intense, but areal coverage was scattered. In general, stratiform precipitation was most prevalent over the southern SPACE mesonet from 3 June to 11 June, and from 13 July to 15 July. Lack of stratiform precipitation close to the Doppler radars during other time periods was somewhat surprising.

The following section describes in detail daily weather events and experimental operations.

References

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Weisman, M.L. and J.B. Klemp, 1984: The structure and classification of numerically-simulated convective storms in directionally varying environments. *Mon. Wea. Rev.*, **112**, 2479-2499.

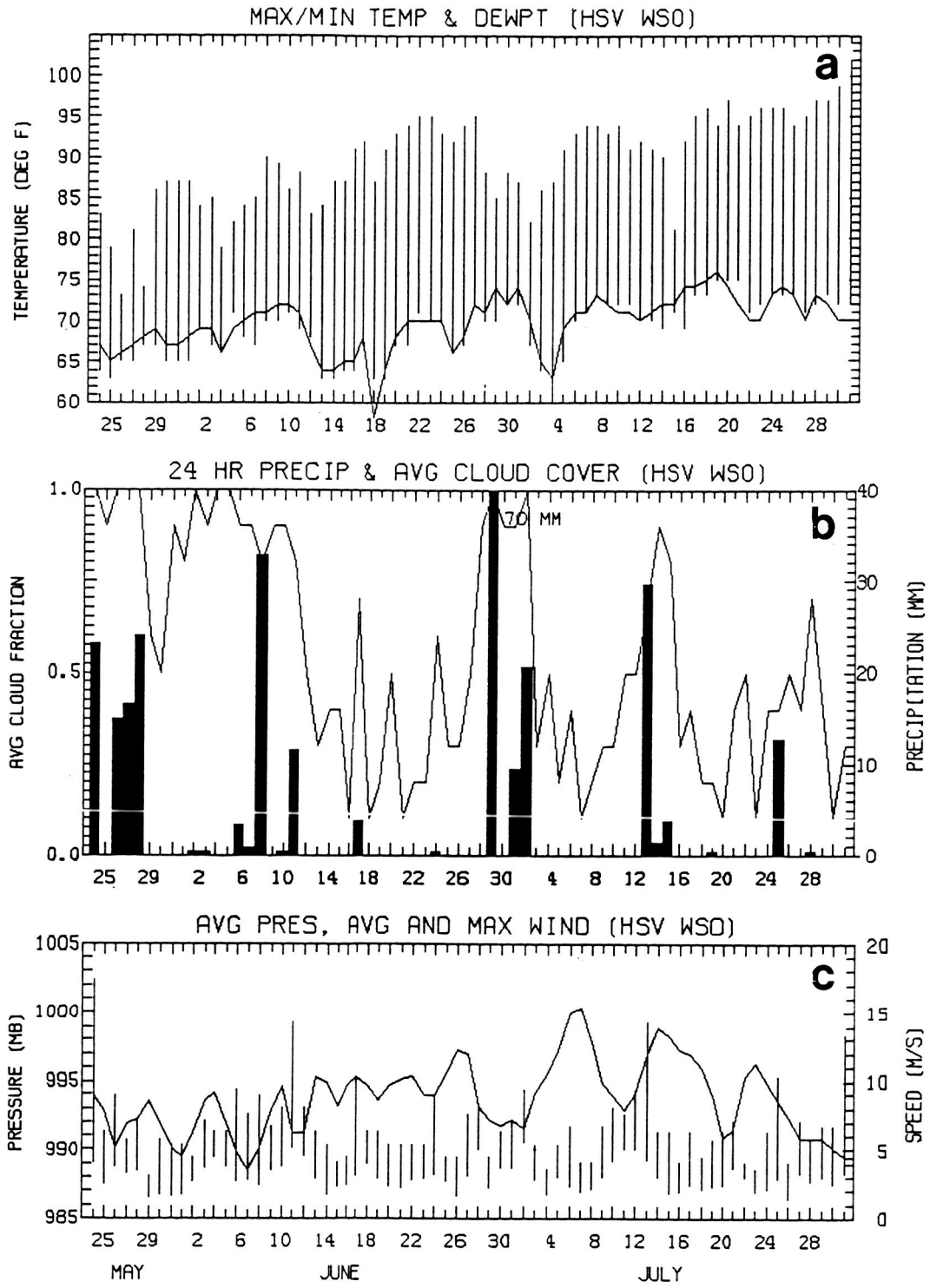


Fig. 3.1-1. General weather conditions at the Huntsville (HSV) Weather Service Office during June and July 1986. (Top) Maximum/minimum temperatures and average dewpoint. (Middle) Average cloud cover and 24-h precipitation (histogram). (Bottom) Average pressure with the average and maximum wind speed.

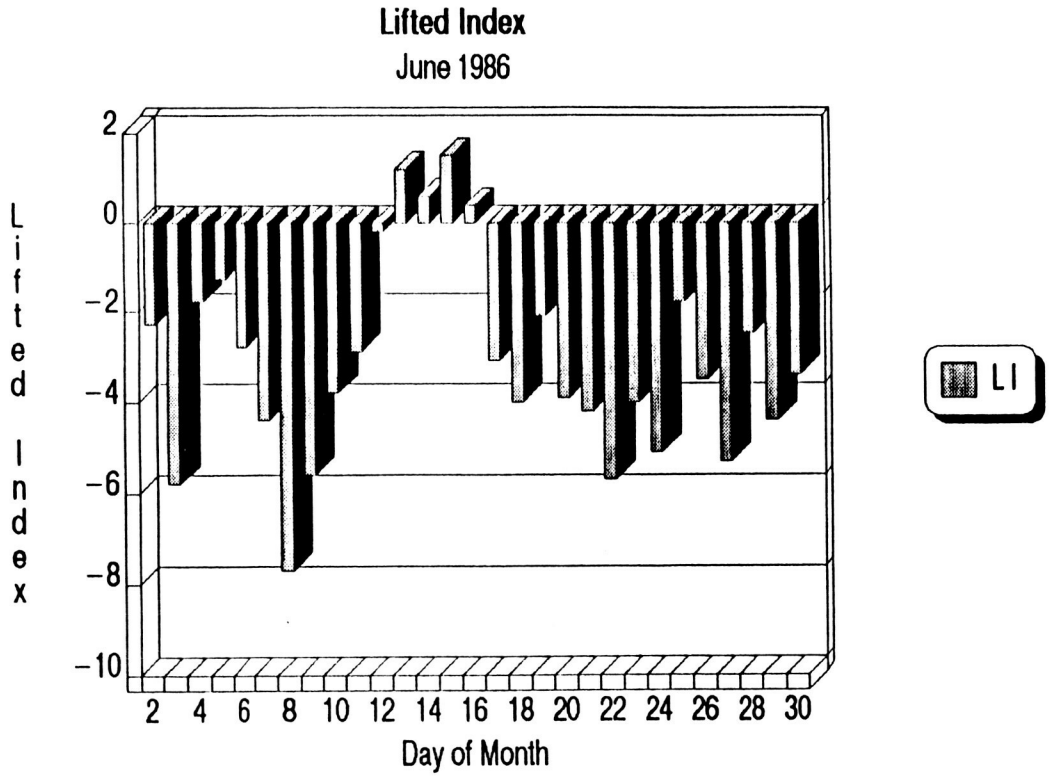


Fig. 3.1-2a. Lifted Index (°C) from daily rawinsonde soundings during June 1986.

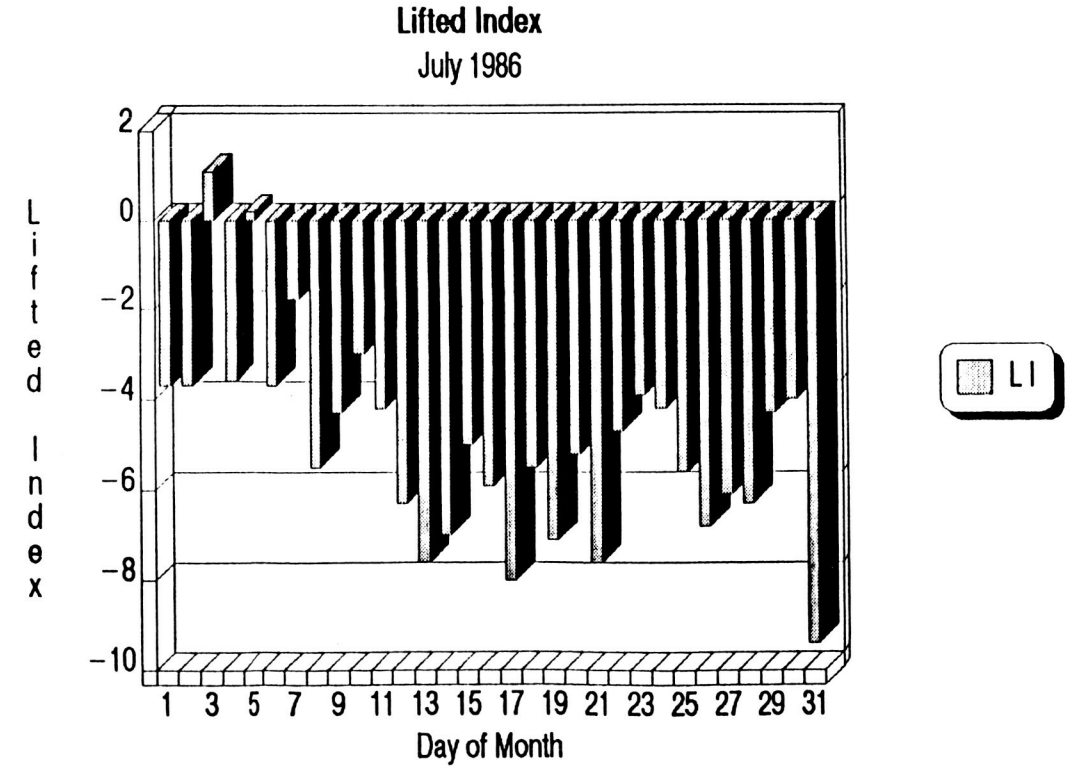


Fig. 3.1-2b. Lifted Index (°C) from daily rawinsonde soundings during July 1986.

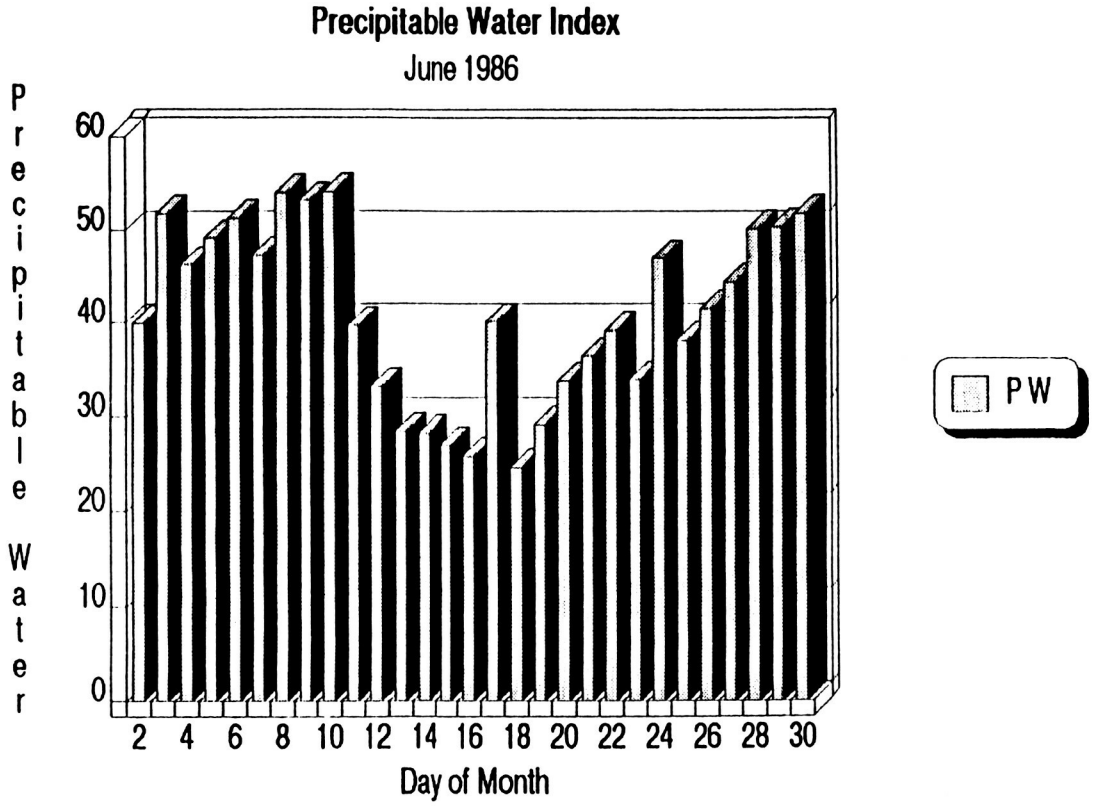


Fig. 3.1-3a. Precipitable Water (mm) from daily rawinsonde soundings during June 1986

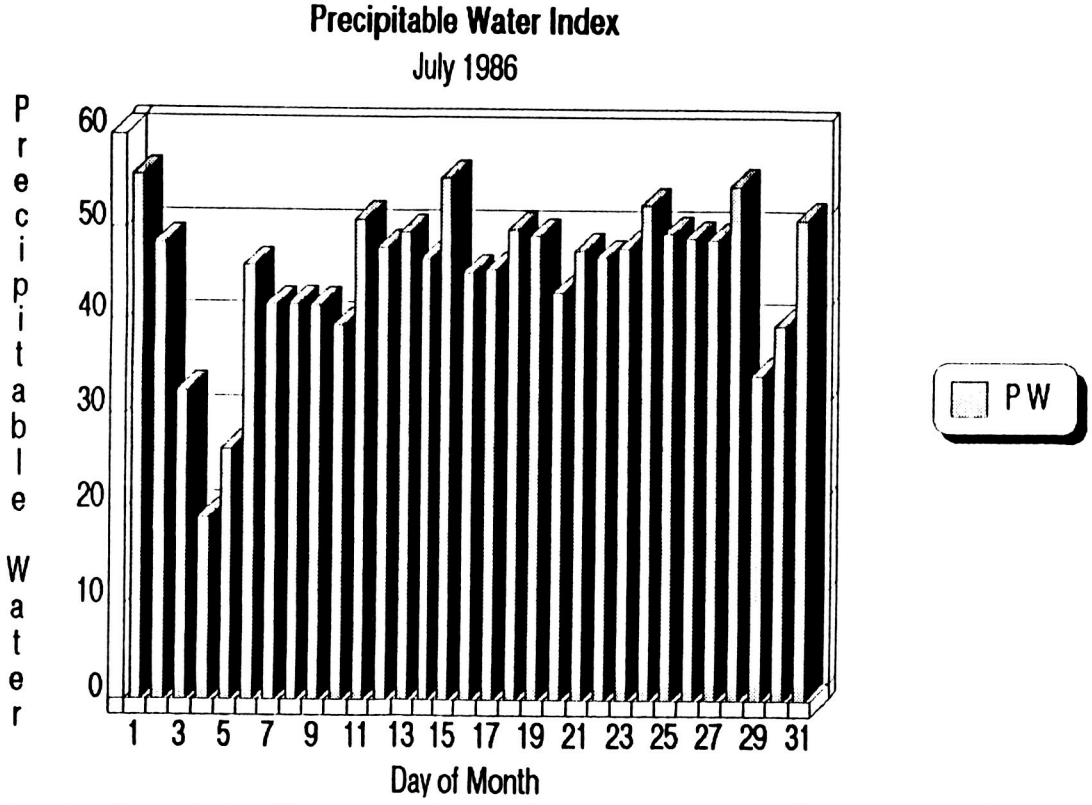


Fig. 3.1-3b. Precipitable Water (mm) from daily rawinsonde soundings during July 1986.

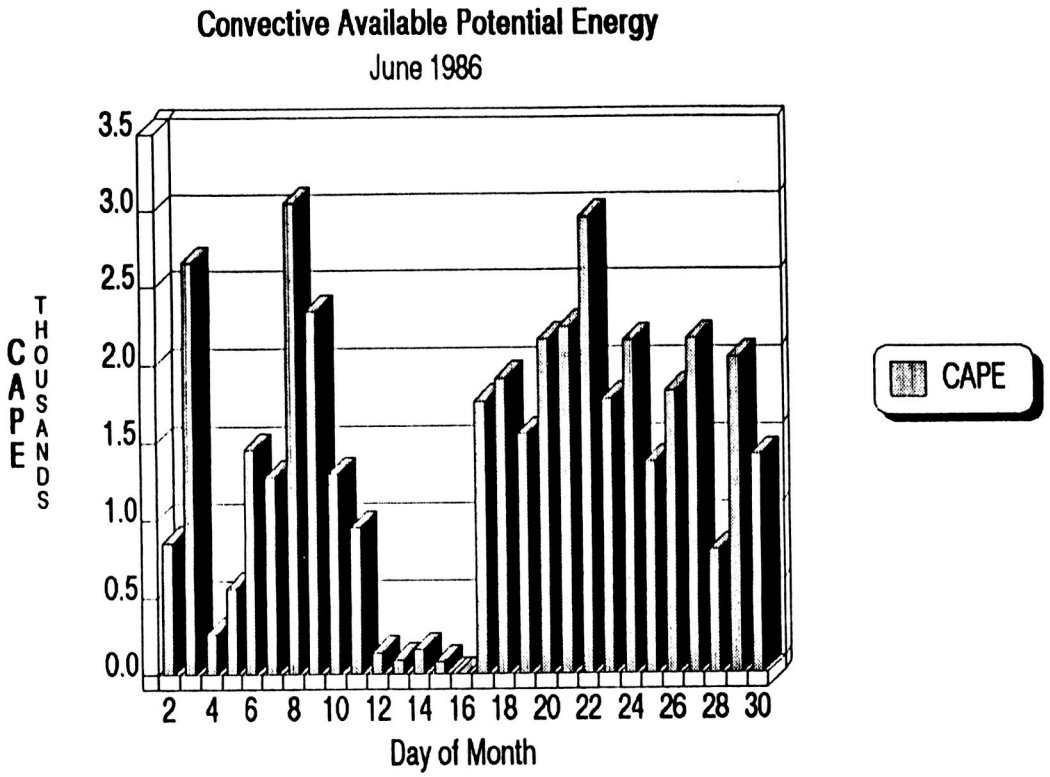


Fig. 3.1-4a. Convective Available Potential Energy (J kg^{-1}) from daily rawinsonde soundings during June 1986.

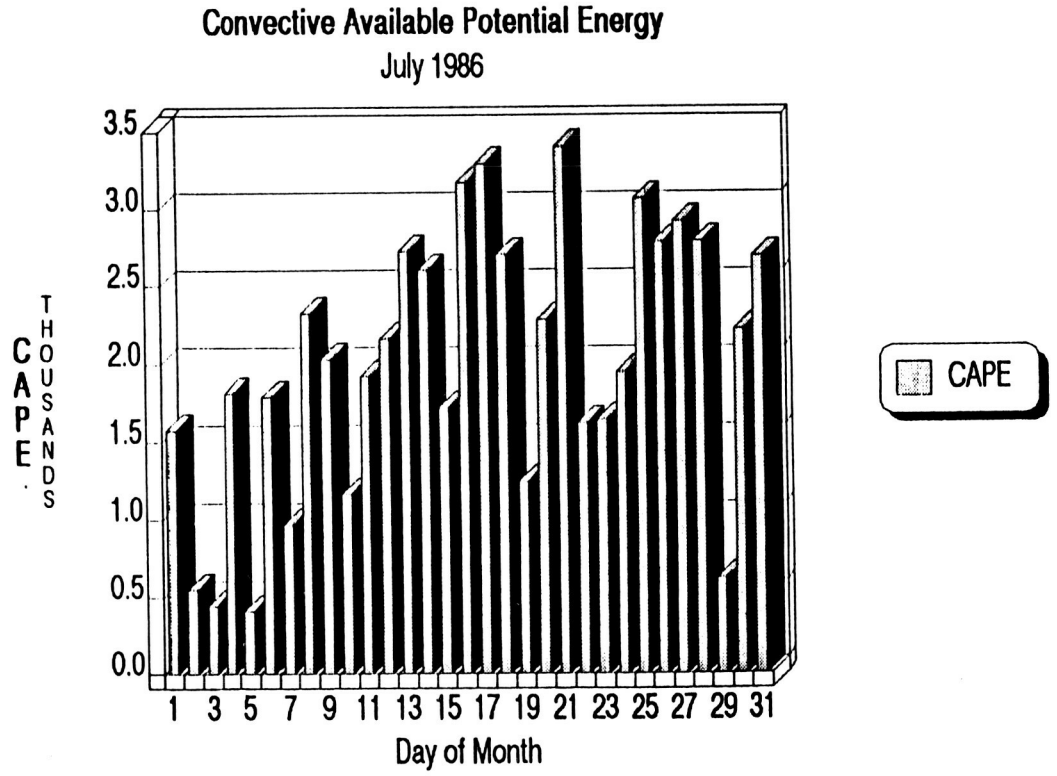


Fig. 3.1-4b. Convective Available Potential Energy (J kg^{-1}) from daily rawinsonde soundings during July 1986.

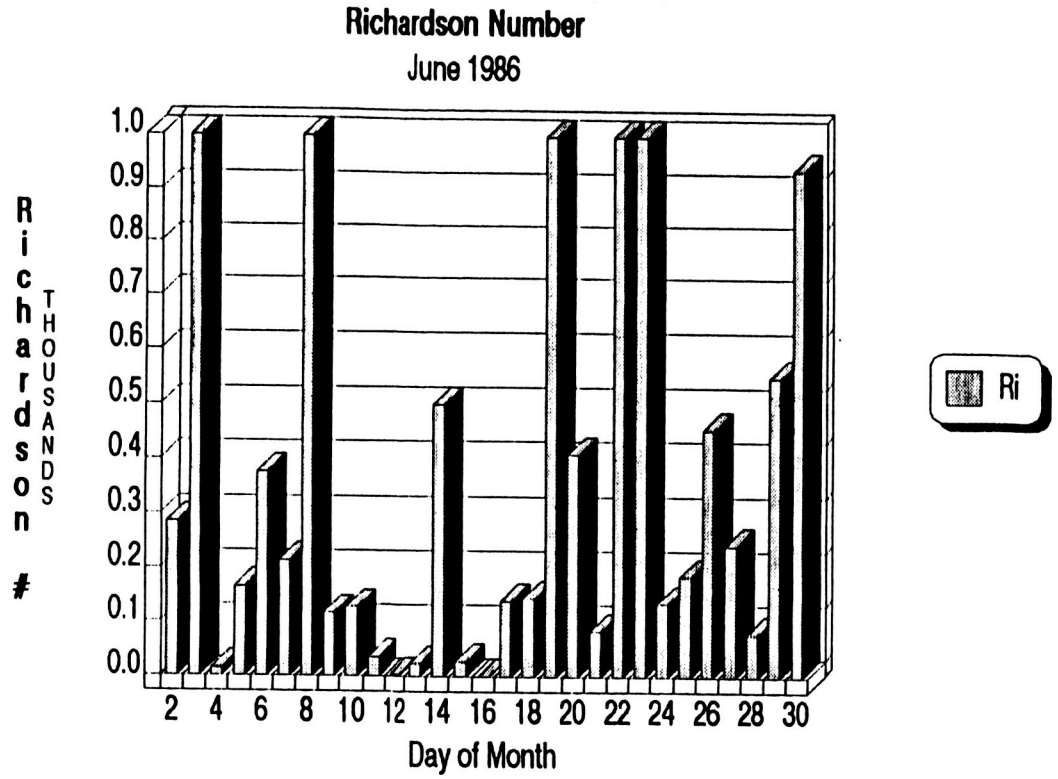


Fig. 3.1-5a. Richardson Number from daily rawinsonde soundings during June 1986

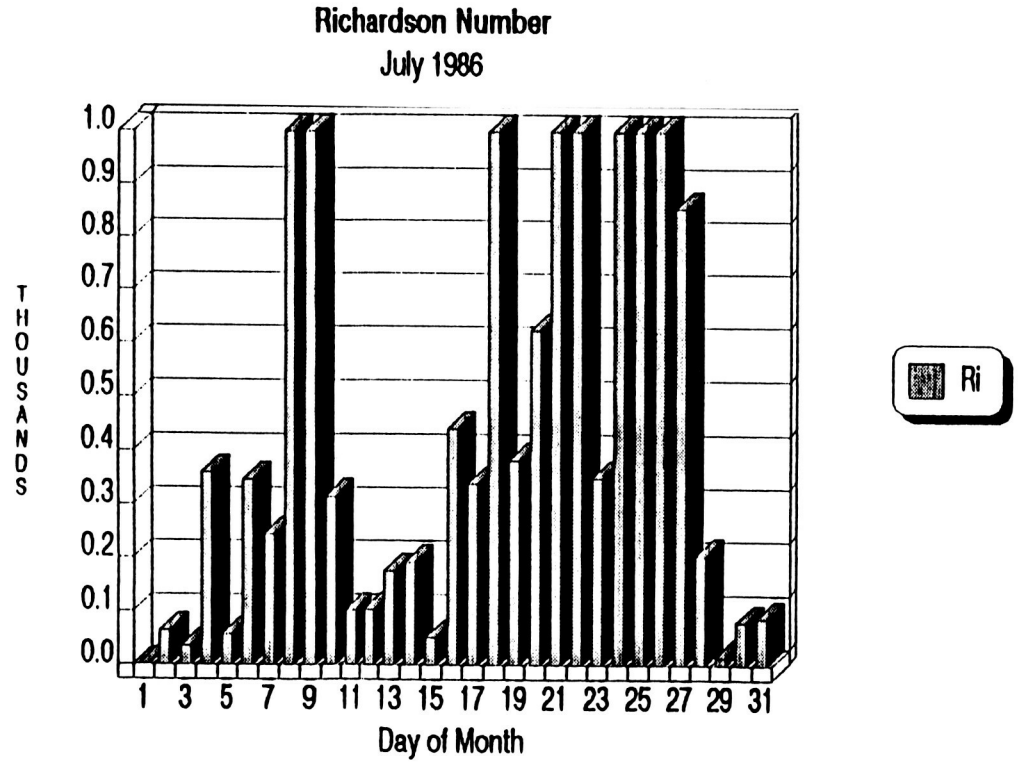


Fig. 3.1-5b. Richardson Number from daily rawinsonde soundings during July 1986.

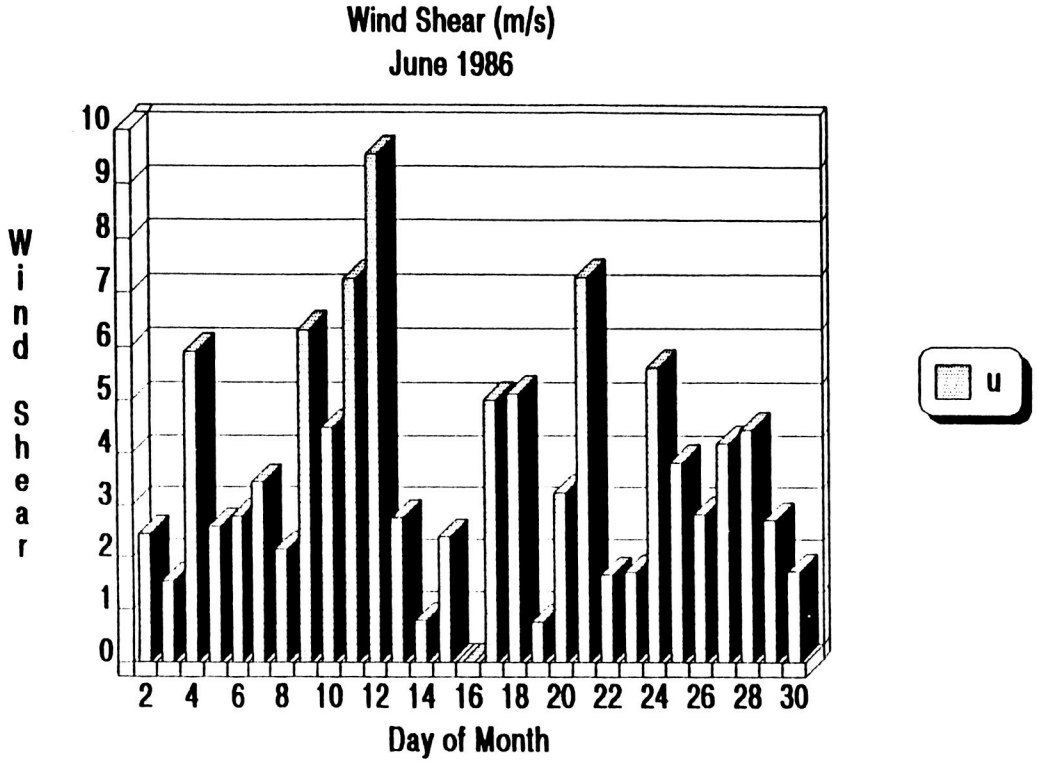


Fig. 3.1-6a. Wind shear from daily rawinsonde soundings during June 1986.

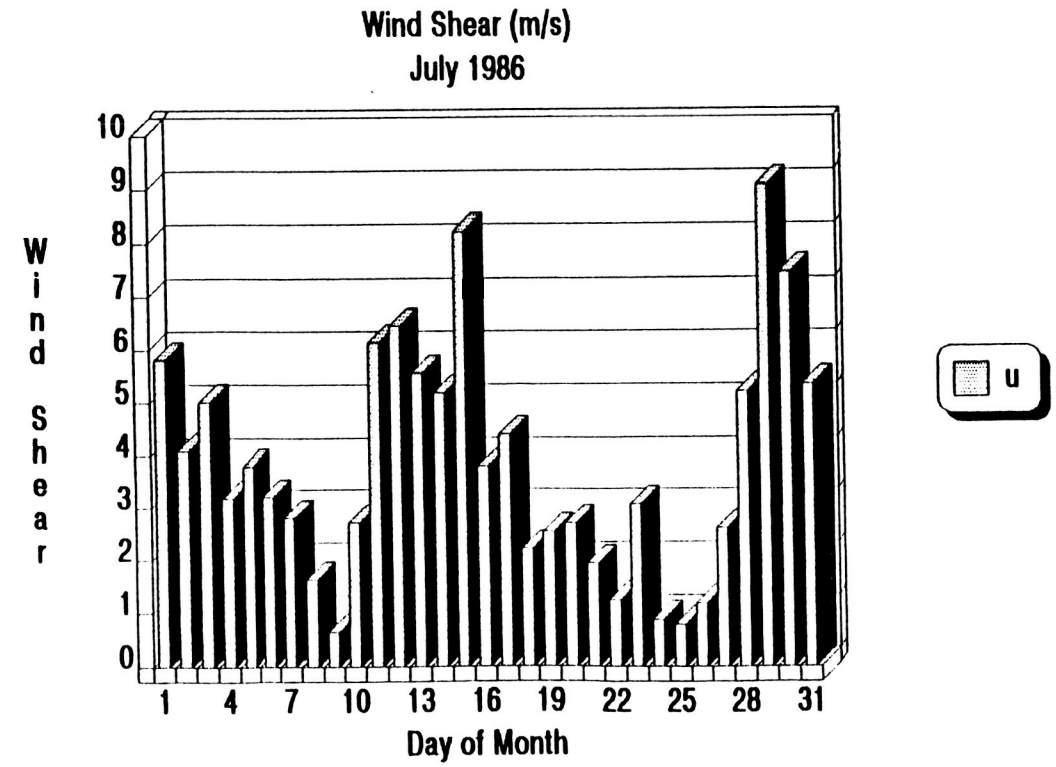


Fig. 3.1-6b. Wind Shear from daily rawinsonde soundings during July 1986.

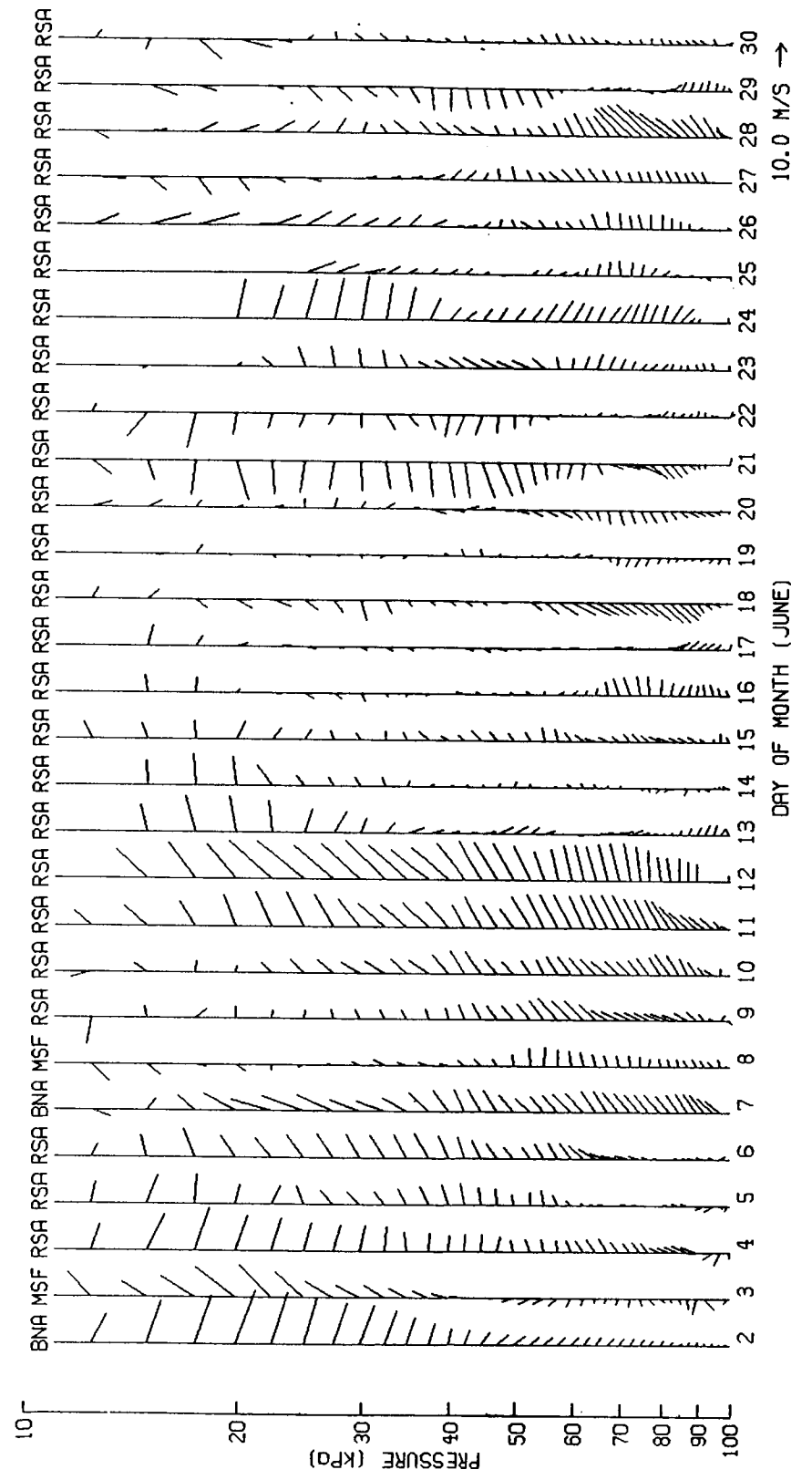


Fig. 3.1-7a. Daily vertical profiles of wind during June, 1986. Most measurements are taken from the 1800 GMT Redstone Arsenal, AL (RSA) sounding. When RSA soundings were not available, 1200 GMT Nashville, TN (BNA) soundings, or soundings released from NASA/MSFC, AL (MSF) close to 1800 GMT were used. **Please note:** *The wind directions on the figure are vectors and not wind barbs. Therefore, these vectors depict the direction to which the wind is heading.*

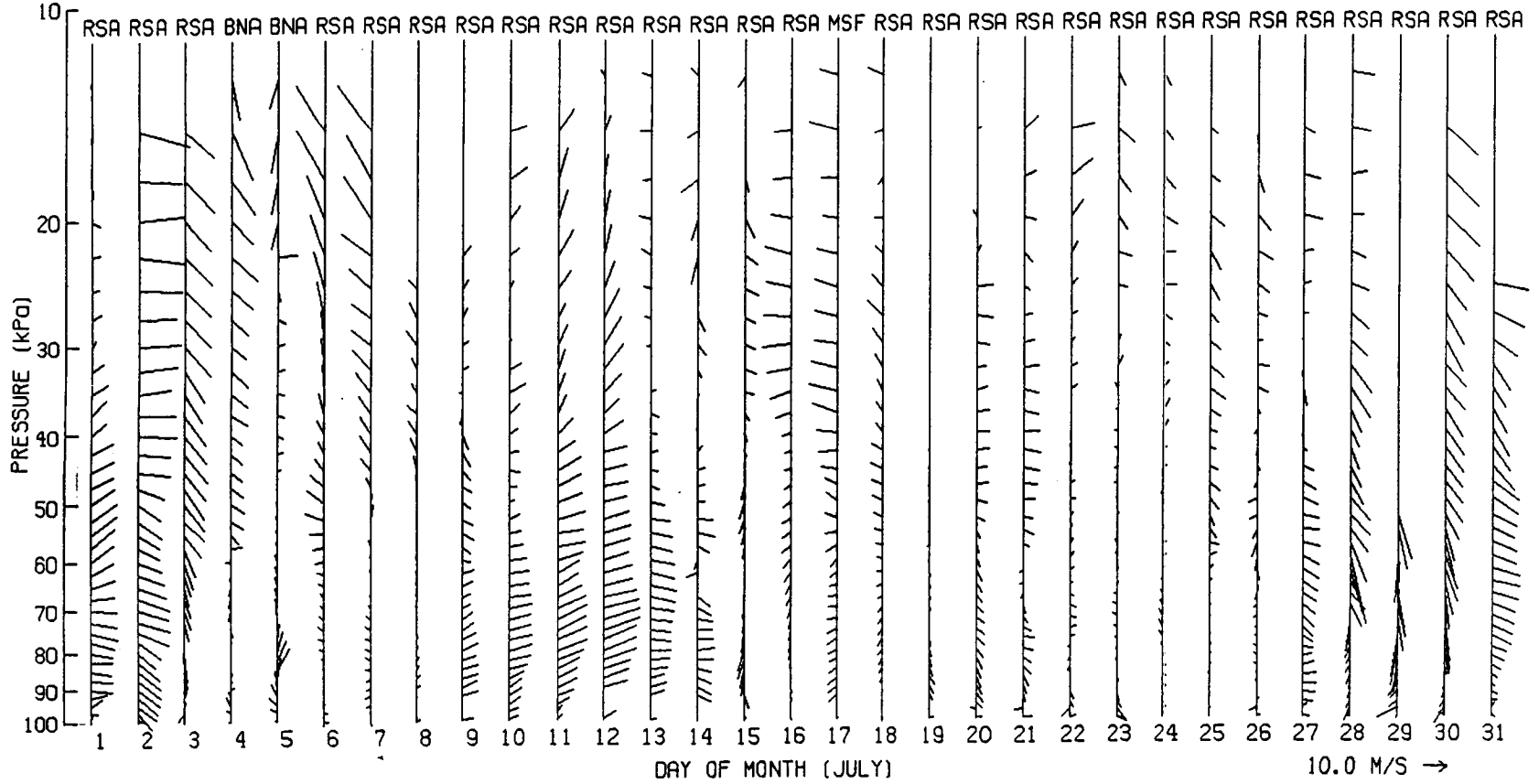


Fig. 3.1-7b. Same as Fig. 3.1-7a except during July, 1986. **Please note:** *The wind directions on the figure are vectors and not wind barbs. Therefore, these vectors depict the direction to which the wind is heading.*

Table 3.1-1. Abbreviated daily weather and precipitation events for June.

DAY	BRIEF WEATHER DESCRIPTION
June 2	Scattered TRW, locally heavy rainfall over both SPACE and MIST/FLOWS mesonets.
June 3	Scattered TRW over the SPACE net, a few intense cells, some stratiform precipitation.
June 4	Early morning showers, quiet afternoon, evening MCS moved into and dissipated over the western SPACE mesonet.
June 5	Moderately weak convective line and stratiform precipitation over the western and central SPACE mesonet.
June 6	MCS over the western and central SPACE mesonet, scattered TRW elsewhere.
June 7	Scattered RW and TRW, many moderately intense over the northern SPACE mesonet.
June 8	Active TRW, locally-heavy rainfall, vigorous outflow, stratiform precipitation.
June 9	Weak RW during the morning, clearing by mid-afternoon.
June 10	Convective/stratiform line over the central SPACE and MIST/FLOWS networks.
June 11	Active day with early MCS over the western SPACE net, and late squall line over the central SPACE mesonet. Passage of SWT over the SPACE mesonet.
June 12	Cold frontal passage by 1200 GMT, stable post-frontal conditions thereafter.
June 13	Suppressed day, no TRW or RW.
June 14	Suppressed day, no TRW or RW.
June 15	Suppressed day, no TRW or RW.
June 16	Very weak isolated RW over the SPACE mesonet.
June 17	Cold frontal passage, scattered intense TRW along front, strong outflow and heavy rain over the MIST/FLOWS mesonet.
June 18	Stable post-frontal day, no TRW or RW.
June 19	Isolated weak TRW/RW over NE corner of the SPACE mesonet.
June 20	Widely-scattered and weak RW/TRW.
June 21	Isolated intense multicell TRW 50 km east of the MIST/FLOWS mesonet over hills, rest of SPACE mesonet remained inactive.
June 22	Weak isolated RW over W and SW SPACE mesonet.
June 23	Persistent and intense multicell TRW over the E central SPACE net, scattered TRW over N SPACE net, evening MCS over N SPACE net.
June 24	Surface trough plus cold front over the SPACE net; widespread intense TRW from MIST net to S SPACE net (MCS).
June 25	Stable post-frontal day, no TRW or RW.
June 26	Isolated TRW and RW SW of MIST/FLOWS mesonet late afternoon to early evening.
June 27	Scattered weak to moderate RW and TRW over SE SPACE mesonet.
June 28	Hurricane Bonnie remnants (clouds and SWT), widespread precipitation, region of intense TRW over central SPACE net late afternoon to early evening.
June 29	Early morning convective line that produced heavy rain over MIST/FLOWS net, scattered afternoon TRW over SPACE mesonet, some intense.
June 30	Weak RW around the MIST/FLOWS net, stronger TRW over N SPACE net.

Abbreviations: TRW - thunderstorm, RW - shower, MCS - mesoscale convective system (defined as a cluster of merged TRW/RW), SWT - short-wave trough

Table 3.1-1 (continued). Abbreviated daily weather and precipitation events for July.

DAY	BRIEF WEATHER DESCRIPTION
July 1	Widely-scattered, intense TRW and RW, decreasing in intensity during the afternoon.
July 2	Cold frontal and SWT passage, prefrontal precipitation band with embedded TRW/RW.
July 3	Stable post-frontal conditions, air mass cooler and much drier.
July 4	Stable conditions, developing upper-level ridge over the SPACE mesonet.
July 5	Building upper-level ridge over N Carolina, moisture return over SW SPACE net, weak isolated RW.
July 6	Upper-level ridge over N Carolina, increasing low-level moisture, scattered intense TRW over SPACE mesonet and just east of MIST/FLOWS mesonet.
July 7	Numerous weak RW over SPACE mesonet, only one TRW.
July 8	Isolated RW/TRW over SPACE net, intense TRW system 60 km SW of MIST/FLOWS net.
July 9	Small MCS over central and southern SPACE mesonet.
July 10	Scattered weak RW during afternoon over SPACE mesonet, late TRW development over NW MIST/FLOWS net.
July 11	Wide variation of numerous but scattered RW and TRW over and around the MIST/FLOWS net,some weak and some intense. Late MCS over the SE SPACE mesonet.
July 12	Isolated RW during afternoon, dissipating MCS with deep outflow over the SPACE and MIST net early evening.
July 13	Development of a MCS over central and southern SPACE net and MIST net, intense TRW, vigorous outflow, heavy rain and large area of stratiform precipitation.
July 14	MCS development over SPACE network, but limited stratiform precipitation; intense TRW with heavy rain and strong outflow.
July 15	Small MCS over SPACE net from morning to early afternoon, clearing over the SPACE mesonet thereafter. Afternoon TRW line over N SPACE net.
July 16	Scattered TRW over SPACE and MIST/FLOWS net, moderate in intensity.
July 17	Intense TRW over central SPACE net, late MCS over SE border of SPACE net.
July 18	Scattered TRW over NW and S borders of SPACE net.
July 19	Intense TRW just NE of MIST net, strong outflow.
July 20	Isolated intense TRW just E of MIST/FLOWS net, TRW line over N central SPACE net.
July 21	TRW along S border of SPACE mesonet, clear elsewhere.
July 22	TRW along S and SE border of SPACE mesonet, clear elsewhere.
July 23	Clear, dry day over the SPACE net, some TRW along the SE border of the SPACE net.
July 24	Intense TRW over SE SPACE net, just SE and E of the MIST net.
July 25	Intense TRW over MIST/FLOWS and central SPACE mesonets, well-defined outflows.
July 26	Small MCS development over the central SPACE net, late evening large MCS moved into the SPACE net from the NW.
July 27	Mostly clear and suppressed.
July 28	Late development of very intense TRW over the E SPACE mesonet, just E of the MIST/FLOWS mesonet, electrically active.
July 29	Isolated weak TRW over the central SPACE net during the afternoon.
July 30	Hot, dry day.
July 31	Active MCS day over the SPACE net (3 MCS's), intense TRW with large hail, strong outflow and much lightning.

Abbreviations: TRW - thunderstorm, RW - rain shower, MCS - mesoscale convective system (defined as a cluster of merged TRW/RW), SWT - short-wave trough

3.2 Daily summaries

Data collected during the COHMEX period (June 2 - July 31) are summarized in Tables 3.2-1 and 3.2-2 for June and July 1986, respectively. These tables provide a general reference of data collection by day of the month to assist the researcher in determining case study days. A more detailed data collection summary is included in the daily summaries that follow.

This section contains a detailed description of each day's conditions and data collection during the field program (June 2 - July 31). The six page format for each day is consistent to allow easy comparison between days. Text includes a daily synoptic and cloud/precipitation overview, with a summary of aircraft, rawinsonde, radar, and satellite operations. Room for researcher's notes and comments have been provided. Figure (a) presents the national 1200 GMT surface, 500 mb, minimum/maximum temperatures, and 24-h precipitation maps (Daily Weather map Series).

The hourly collection of COHMEX data are presented in Table (a). Bar graphs indicate data collection times from 1000 GMT to 1200 GMT (following day) for Sounding Systems, Radars, Remote Sensors, Aircraft, Satellite, and Surface Systems individual platforms. Cross hatching in the RADAP row indicates times when only ICRAD data was available. The times listed for remote sensors are the takeoff and landing times of the high altitude aircraft at the Wallops Flight Facility (WFF). The flight time from WFF to the SPACE network was approximately 1.5 h. The aircraft could remain over the network for a maximum of 3.5 h before returning to WFF. A few of the high altitude flights were not flown over the SPACE network. These are designated as "NS" in the table. See Appendix A for a detailed plot of the flight tracks and times of each mission. Times indicated for the aircraft are also takeoff and landing times from their respective airports. The GOES satellite data listed in the table represent only the data presently archived at MSFC. Additional images will be added to the data base at a later time. The approximate overpass times of the polar orbiting satellites are designated by triangles in the table. These images are not archived at MSFC.

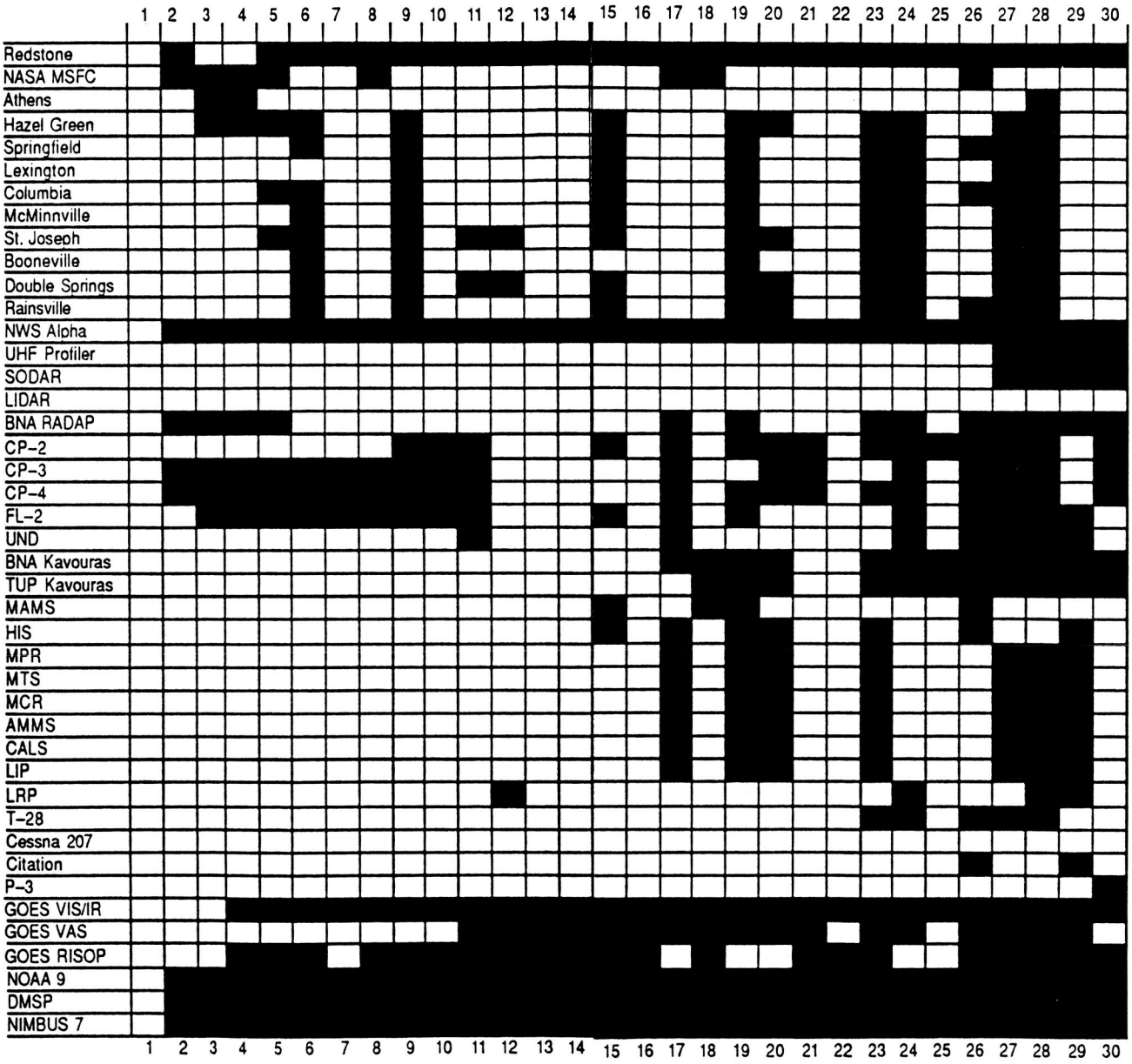
A daily satellite image is presented in Fig. (b). Most of these images are visible 2 km resolution, taken during the afternoon (i.e. 1800 GMT - 2300 GMT) when convective activity is at a peak. Four km resolution infrared images were used when maximum convective activity occurred at night.

A daily rawinsonde sounding (skew-T diagram) is presented in Fig. (c). Most of these soundings were taken at Redstone Arsenal or MSFC at approximately 1800 GMT. Soundings from the NWS Nashville, TN, station (1200 GMT) were used when any local soundings were not available. Calculations of Precipitable Water (PW), Lifted Index (LI), Convective Available Potential Energy (CAPE), and the Richardson number (RI) are included below each figure. **Please note:** *The wind directions on the skew-T diagram are vectors and not wind barbs. Therefore, these vectors depict the direction to which the wind is heading.*

Figure (d) depicts a 24-h composite (1200 GMT to 1159 GMT) of lightning ground strike density for the SPACE network. Each gray scale represents a higher level of lightning density as indicated in the figure's legend. The data used in these plots have not been corrected for measured site errors.Totals of rainfall for approximately the same 24-h time (1100 GMT to 1100 GMT) period (Fig. (e)) are presented using the TVA ADAS raingage network data.

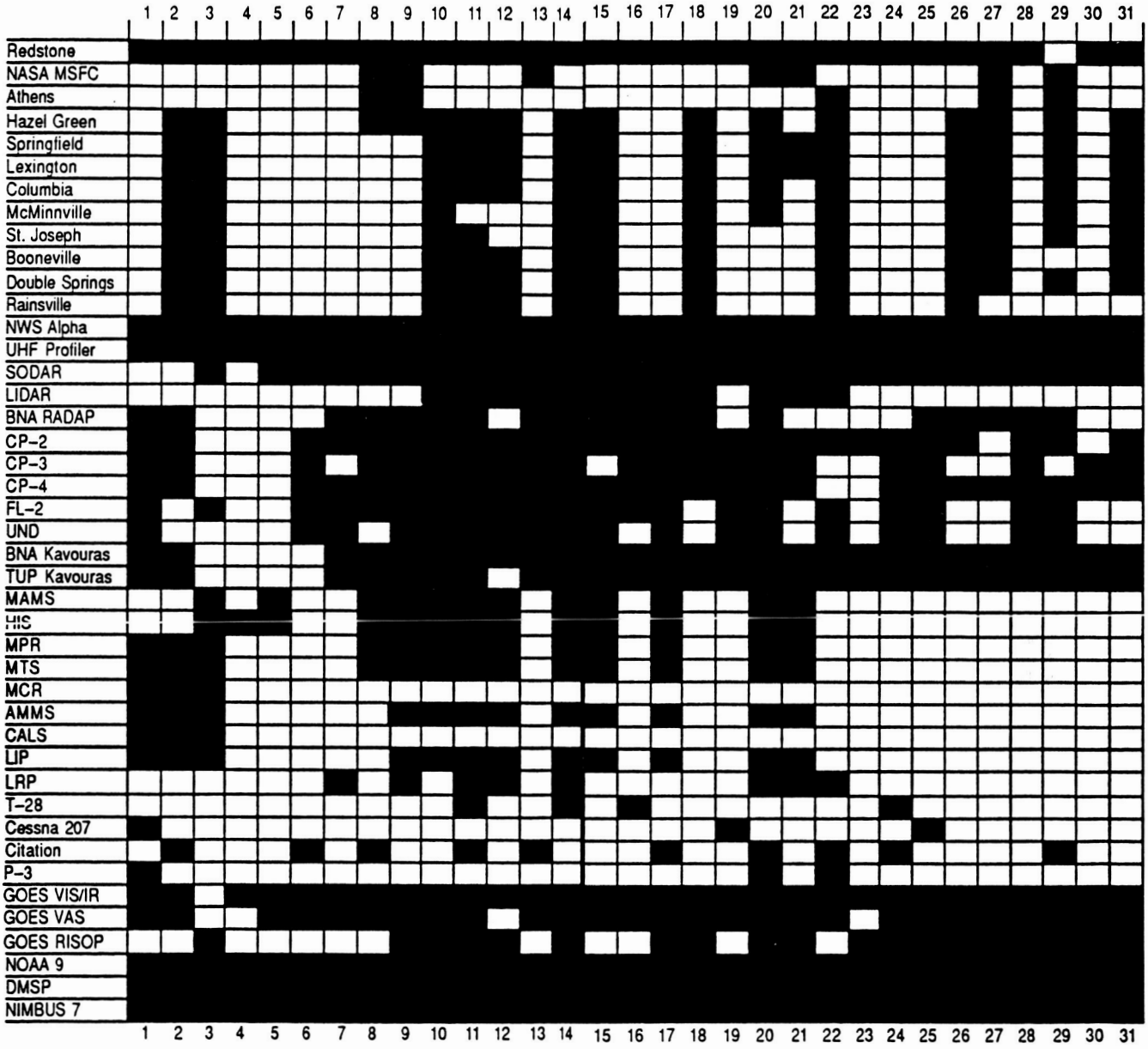
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TABLE 3.2-1 COHMEX Daily Data Collection Summary for June 1986



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TABLE 3.2-2 COHMEX Daily Data Collection Summary for July 1986



SYNOPTIC AND PRECIPITATION OVERVIEW

2 June 1986

Synoptic Conditions

A surface anticyclone of ~1026 mb intensity moved eastward over the Great Lakes region during the day. This high was associated with a relatively vigorous short wave trough and managed to push a weak cold front into the northern SPACE mesonet during the afternoon and evening. Over the larger synoptic scale, a broad ridge was located over the western U.S. Upper level flow of ~10 m s^{-1} was generally westerly over the SPACE mesonet, and abundant moisture existed from the surface to middle levels. Over the SPACE region, typical surface temperature and dewpoint values were 29 and 20 °C, respectively, while surface flow was weak (~2-3 m s^{-1}) and variable from a northerly direction.

Cloud/Precipitation Overview

Middle level cloudiness persisted during the morning hours and limited afternoon maximum surface temperatures to 26-30 °C. Widely scattered thunderstorm activity formed over the mesonet by 1700 GMT, after which moderately intense thunderstorms were common within or near the MIST/FLOWS network until 2100 GMT. This area of thunderstorm activity appeared to attain maximum coverage and intensity around 1900 GMT. Although individual cells were short-lived, locally heavy rainfall was produced. Another area of stronger thunderstorms formed over northern Tennessee around 1800 GMT. This activity assumed a broken line configuration (oriented east to west), and reached maximum intensity from 2100 to 2300 GMT as the line advanced slowly southward. Reflectivity factor values in some cells near BNA exceeded 57 dBZ. By 0000 GMT, the general linear configuration was replaced by a small cluster of intense thunderstorms just southwest of BNA. Recorded rainfall was isolated, but peaked at 17.5 mm over the MIST/FLOWS network, and at 25 mm over the SPACE network.

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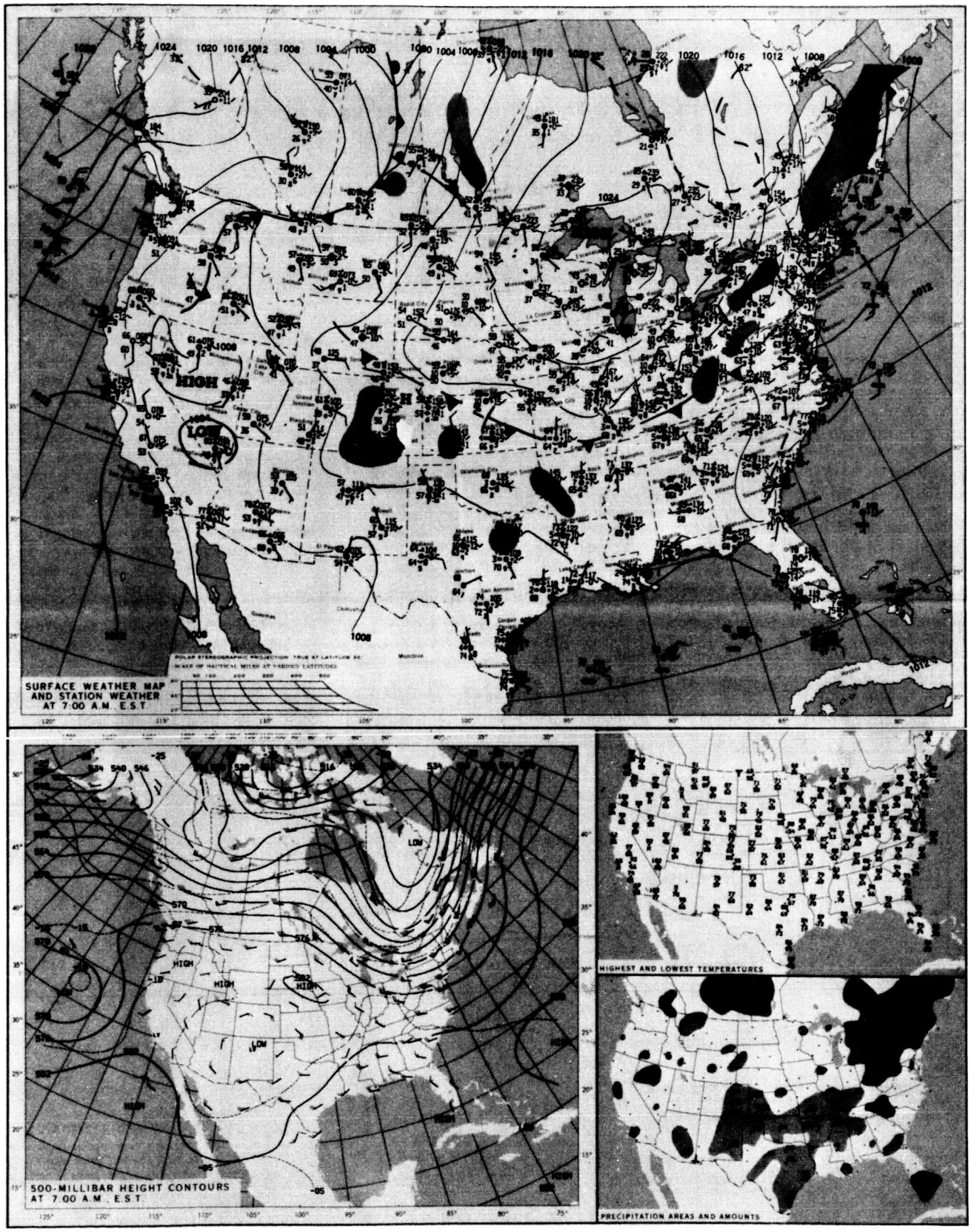


Fig. 3.2-1a. Synoptic weather conditions for 2 June 1986 1200 GMT

OPERATIONAL SUMMARY

2 June 1986

Rawinsonde Operations

Special rawinsondes were launched from NASA/MSFC at 1200, 2100, and 0000 GMT. The latter two soundings were released after local thunderstorm activity peaked, although some secondary development did occur over the western SPACE mesonet around 2300 GMT.

Radar Operations

This was an initial MIST/FLOWS radar shakedown day. Therefore, only limited data were collected by CP-3 and CP-4 in the 2000-2200 GMT time slot. Dual and single Doppler data on several local cells were acquired. CP-2 was not yet operational (and would not be until 10 June), and FL-2 was down due to software modifications.

Satellite Operations

Normal operations.

Aircraft Operations

No operations.

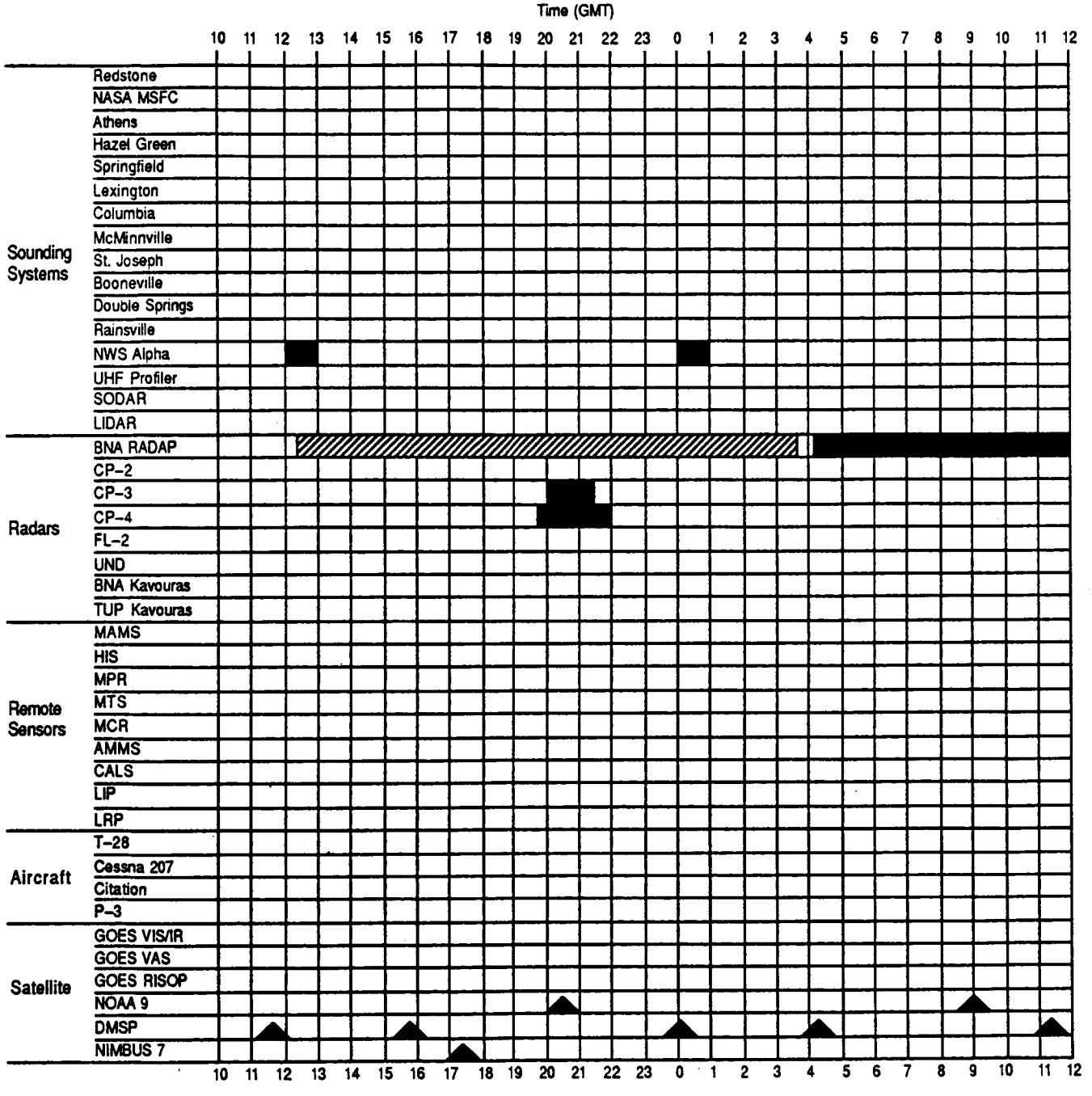
Notes:

5-550-7-8(01)

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Day: MONDAY
Date: 6/2/86
Julian Day: 153–154

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	MISSING STATIONS 4, 8 & 9
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 3, 4, 6, 7, 8 & 9
	TVA ADAS	MISSING STATIONS 15, 27, 45, 56 & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

2 June 1986

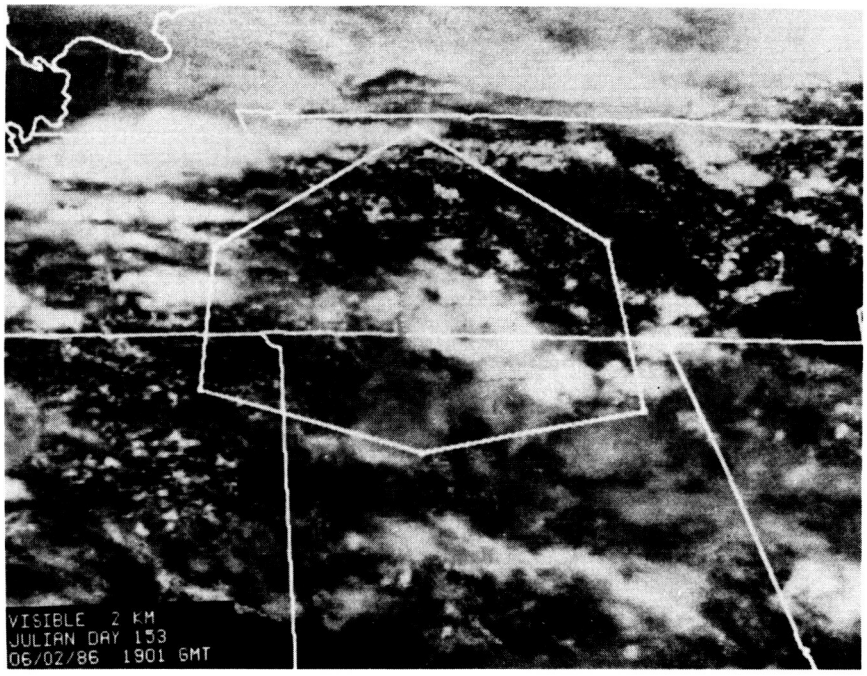
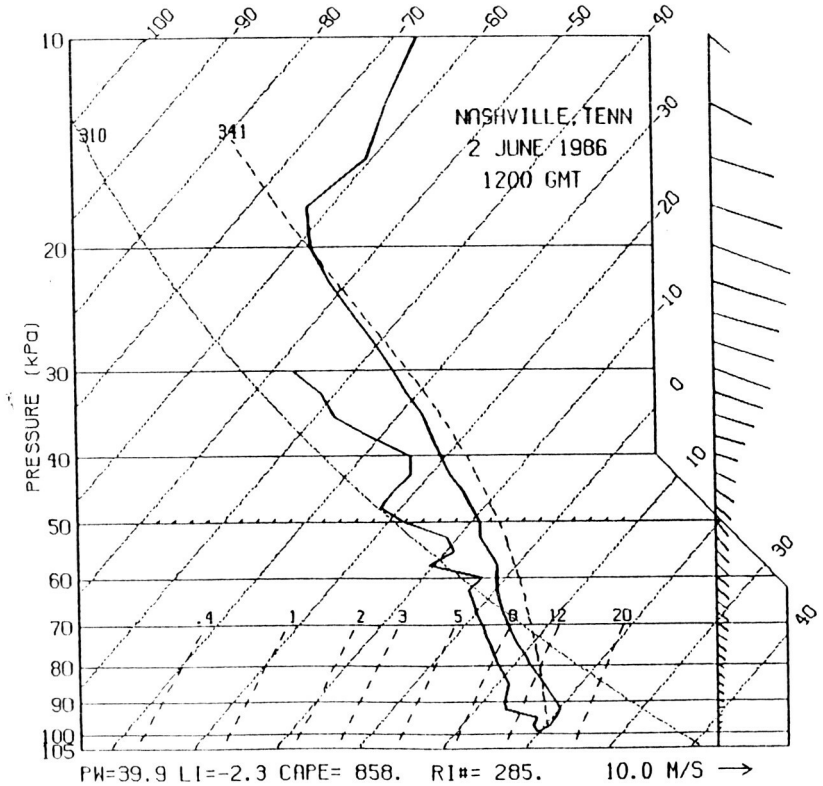


Fig. 3.2-1b. Visible 2 km GOES Central satellite image for 2 June 1986 1901 GMT



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Fig. 3.2-1c. Nashville, TN, rawinsonde sounding for 2 June 1986 1200 GMT

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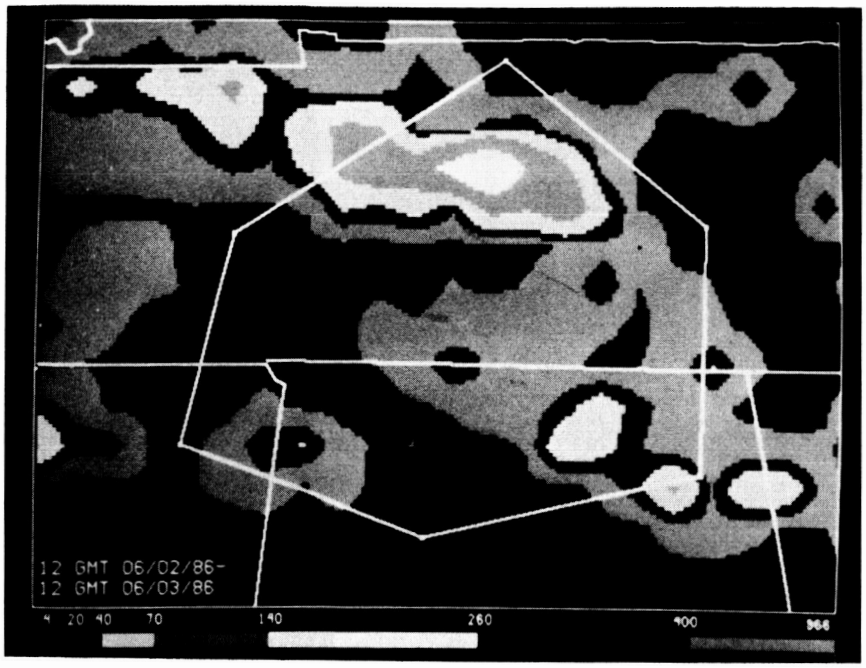


Fig. 3.2-1d. Twenty-four hour lightning strike density plot for 2-3 June 1986

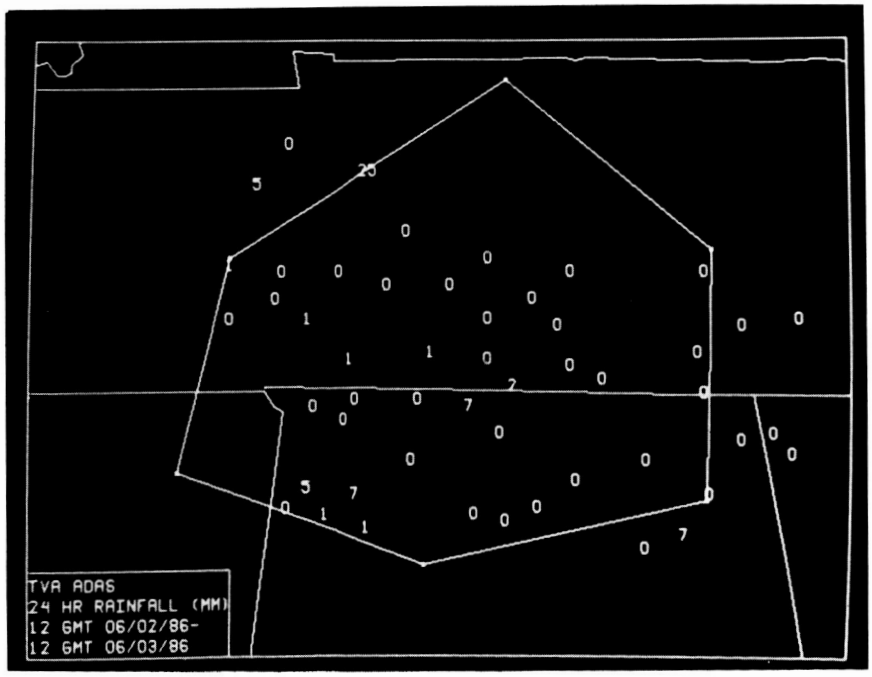


Fig. 3.2-1e. Twenty-four hour TVA ADAS rainfall totals (mm) for 2-3 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

3 June 1986

Synoptic Conditions

The cold front that edged into the northern SPACE region yesterday moved through the southern portion of the mesonet and turned stationary during the day. A broad surface anticyclone moved eastward over the New England states during the day, and a ridge extended southwestward from the high center to over the SPACE network. A relatively moist south to southwesterly flow was present at 850 and 700 mb, with winds above remaining weak as an upper level high showed signs of intensifying over the Southeast. Afternoon temperature and dewpoint values over the SPACE region were 28 and 20 °C in the presence of light and variable flow.

Cloud/Precipitation Overview

Precipitating deep convection began relatively early by 1700 GMT along a boundary associated with an early morning cloud cover over northern Mississippi. Initial activity was confined to the eastern half of the SPACE network, from the MIST/FLOWS network and to the northeast. Cells that formed near the MIST/FLOWS network appeared to be most intense initially, exhibiting strongly diverging tops and moderately strong low level outflow winds of ~15 m s^{-1}. Outflows were commonly associated with individual precipitating cells and appeared to generate secondary convection. Several microbursts were logged by FL-2 personel between 1721 and 1840 GMT near Athens, and also south to southwest of the MIST/FLOWS network. Maximum tops within these cells were ~13 km. By 2000 GMT, a long line of cells extended from near HSV northeastward along the western foothills of the Appalachian Mountains to the Kentucky-Tennessee border. Much of this convection turned stratiform after 2100 GMT. Late afternoon convection was not prominent over the central and northern SPACE network. Rainfall reports were locally heavy, with two 25+ mm reports in the MIST/FLOWS network and two 30+ mm reports over the SPACE network.

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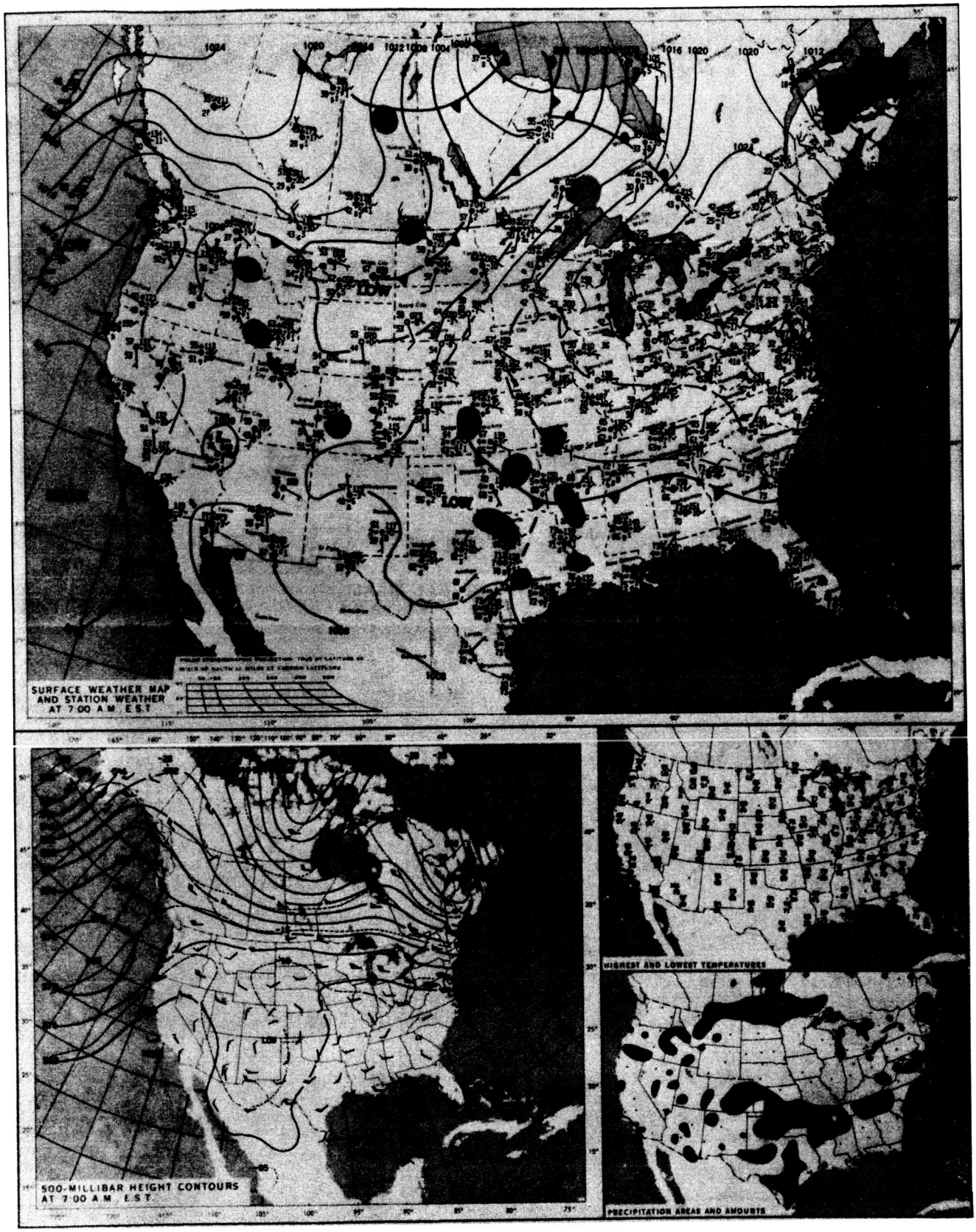


Fig. 3.2-2a. Synoptic weather conditions for 3 June 1986 1200 GMT

OPERATIONAL SUMMARY

3 June 1986

Rawinsonde Operations

Serial ascents were made from the RSA/NASA location at 3-h intervals from 1200 to 0000 GMT. Two sets of releases (2100 and 0000 GMT) were made over the 3 station Meso-gamma network in support of MIST/FLOWS operations. The 2100 GMT release will provide *in situ* data on stratiform precipitation which existed over the MIST/FLOWS network at that time.

Radar Operations

MIST/FLOWS radar operations began near 1800 GMT (after initial microburst activity) and examined existing multicell thunderstorms located over the northwest Doppler sector. CP-3 and CP-4 performed dual Doppler coordinated scans of this activity in both PPI and RHI mode. The storms contained large scale downdrafts and exhibited midlevel vortex signatures. Later on (2020-2100 GMT) VAD scans were implemented by CP-4 within the stratiform precipitation remnants of previous convection.

FL-2 was operational from late morning through the afternoon. A low level convergence zone from which convection was initiated was noted. Seven microbursts (both within and south of the MIST/FLOWS network) and several fine lines were also observed. Cells exhibited reflectivities to 60 dBZ and tops to 14 km.

Satellite Operations

Normal operations.

Aircraft Operations

No operations.

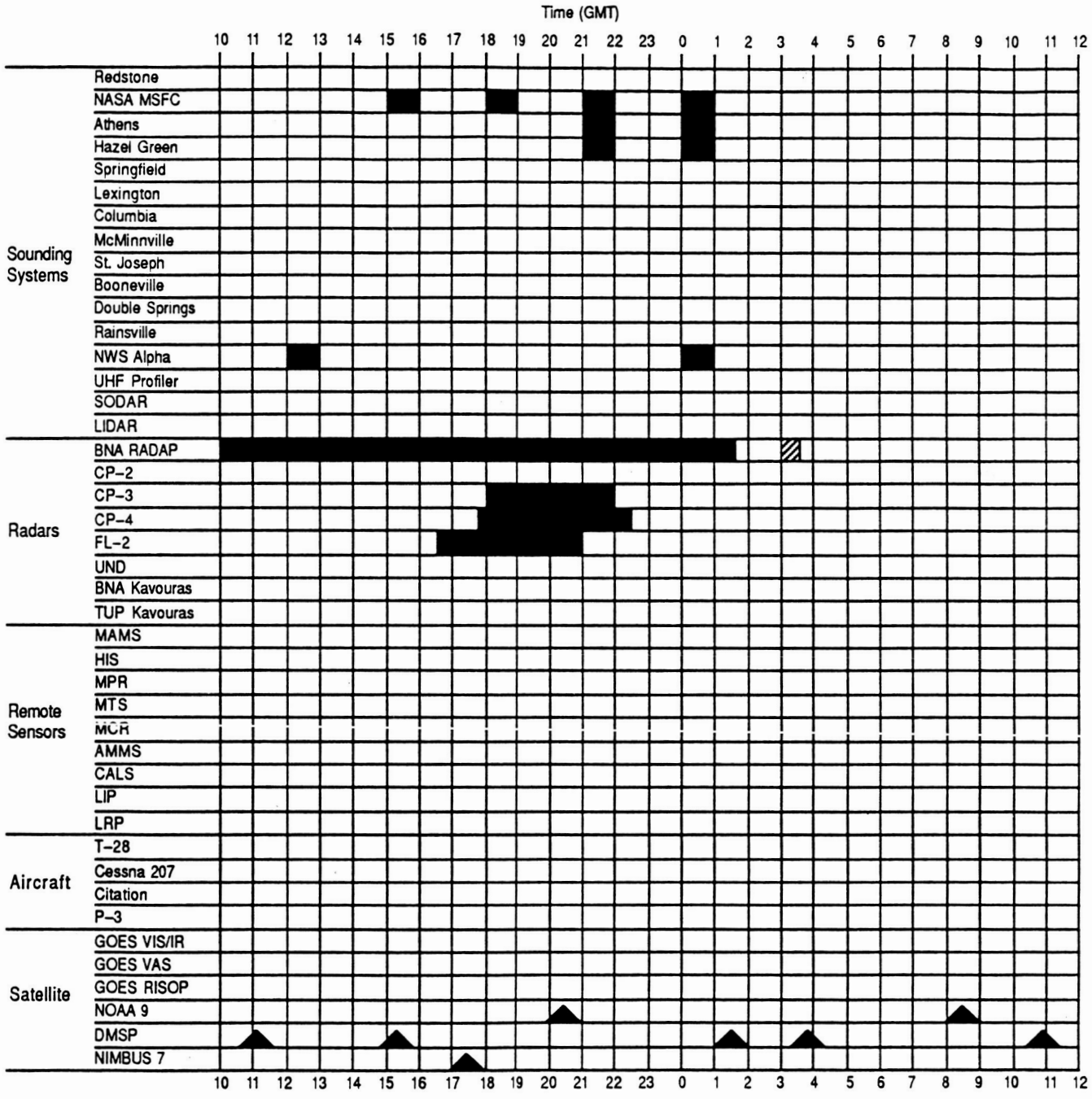
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5-550-7-8(02)

Day: TUESDAY
Date: 6/3/86
Julian Day: 154–155

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL STATIONS 8, 9 (PARTIAL)
	FAM	MISSING STATION 18
	NAM	MISSING STATIONS 4, 6, 8 & 9
	TVA ADAS	MISSING STATIONS 15 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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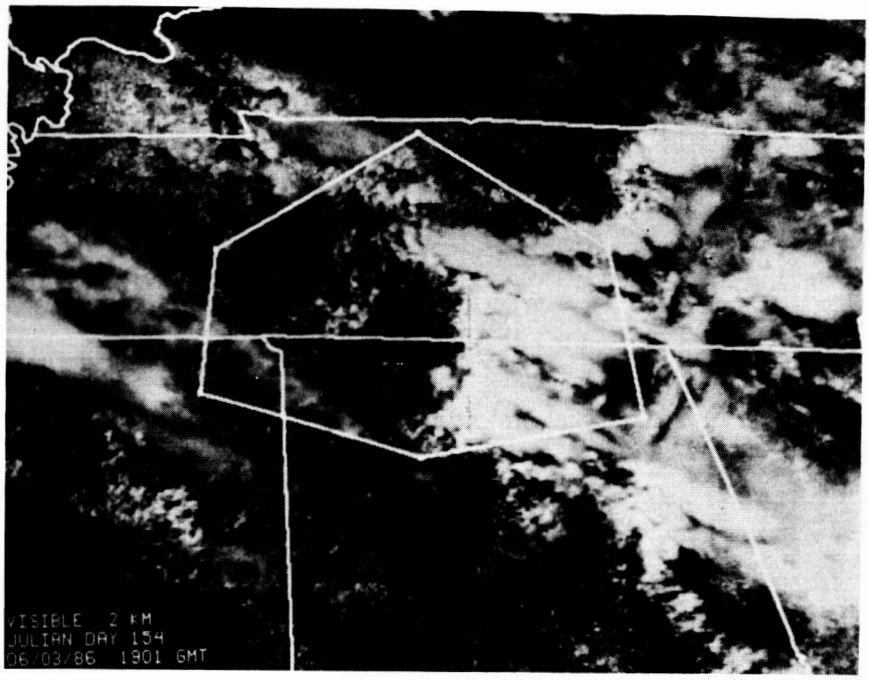


Fig. 3.2-2b. Visible 2 km GOES Central satellite image for 3 June 1986 1901 GMT

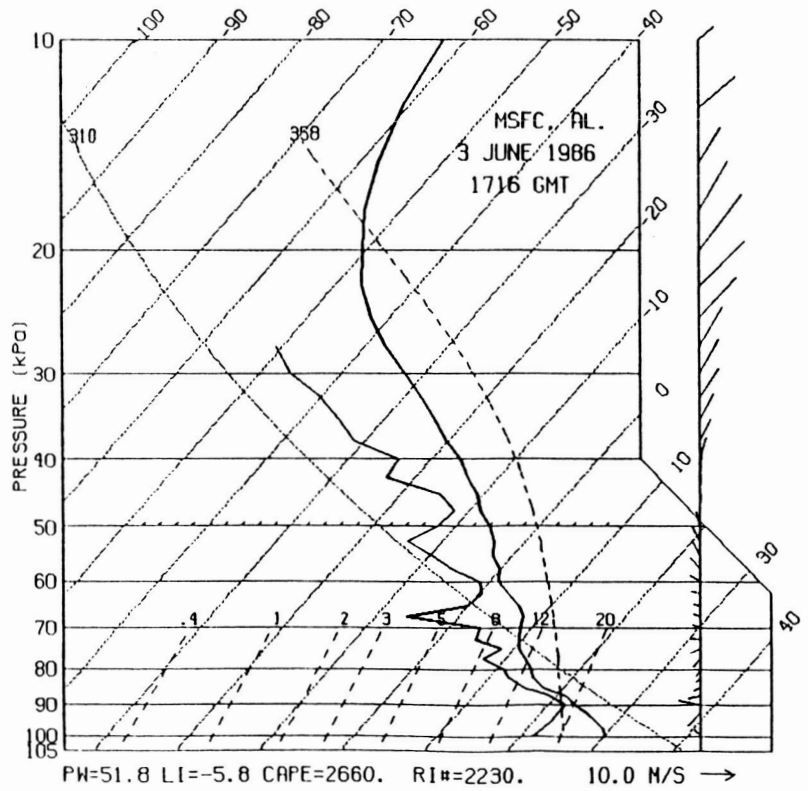


Fig. 3.2-2c. MSFC, AL, rawinsonde sounding for 3 June 1986 1716 GMT

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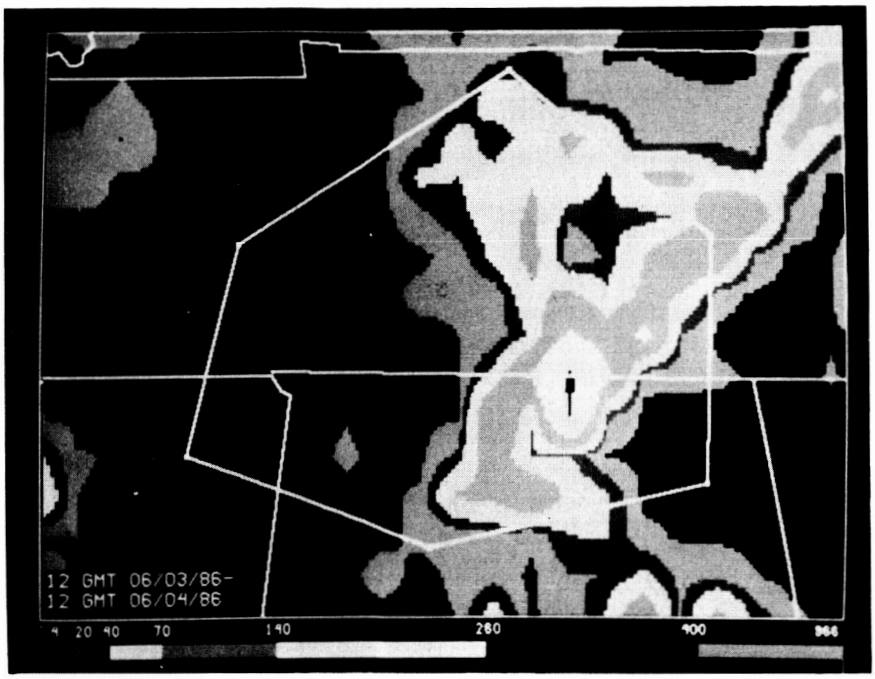


Fig. 3.2-2d. Twenty-four hour lightning strike density plot for 3-4 June 1986

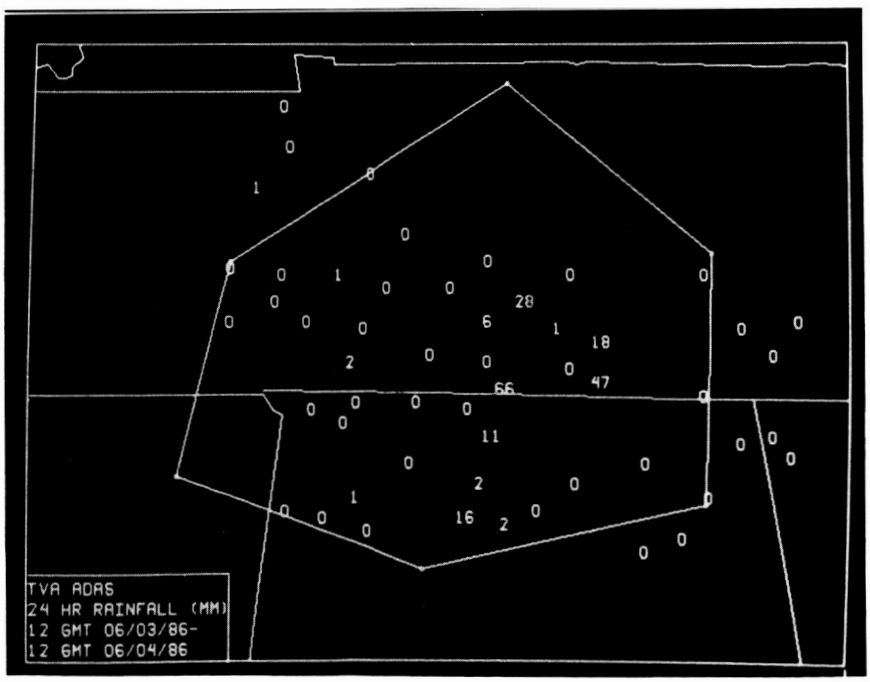


Fig. 3.2-2e. Twenty-four hour TVA ADAS rainfall totals (mm) for 3-4 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

4 June 1986

Synoptic Conditions

East-southeasterly flow behind the "backdoor" cold front which pushed through the region yesterday remained relatively vigorous over the SPACE mesonet today. Widespread cloudiness associated with the post-frontal air produced relatively stable conditions over the eastern two-thirds of the SPACE mesonet. The old frontal zone was located over southern Alabama, and a ridge of high pressure remained over the entire SPACE region. Meanwhile, another cold front associated with a short wave trough over Minnesota approached the region from the north. At upper levels, the ridge of high pressure appeared to be more established along the Atlantic coast. Generally 5-10 m s^{-1} southwesterly flow at lower to middle levels continued to sustain above average moisture over the SPACE mesonet. Afternoon surface temperature and dewpoint values were cooler today, being 25 and 20 °C, respectively.

Cloud/Precipitation Overview

An early morning stratus overcast persisted through the late morning hours, thus limiting maximum surface temperatures to ~ 25 °C over the MIST/FLOWS network. Rain showers developed early (by 1200 GMT) over the SPACE mesonet. At 1330 GMT, a broken line of showers extended from just east of HSV northwest into western Tennessee. Echo intensities of individual cells in the line appeared to peak near 45 - 50 dBZ near 1430 GMT, but (stratiform) echo area continued to expand thereafter, reaching a maximum aerial extent over the eastern SPACE mesonet from 1700 to 1830 GMT. After 1830 GMT, echo area and intensity decreased substantially over the SPACE network, with virtually no echoes present by 2130 GMT. However, an MCS (a north-south line of echoes) began to infiltrate the western beta network at 2130 GMT, and then advanced eastward over the network during the next 7 hours. As it advanced eastward, cell intensity and echo area decreased, apparently in response to moving over more stable low level air over the SPACE network. The origins of this MCS were apparently over Arkansas. During the dissipating stages of this MCS from 0200 to 0400 GMT, 2-3 mesoscale vortices appeared in the stratiform region at the lower midlevels.

Interestingly, positive cloud-to-ground lightning discharges were common during the day, in both the morning shower activity and in the weakening stages of the evening MCS. Precipitation was generally light to moderate over the SPACE network, with some locally heavy amounts (one 47 mm report at a PAM station, not included in Fig. 3.2-3e, over the eastern SPACE network).

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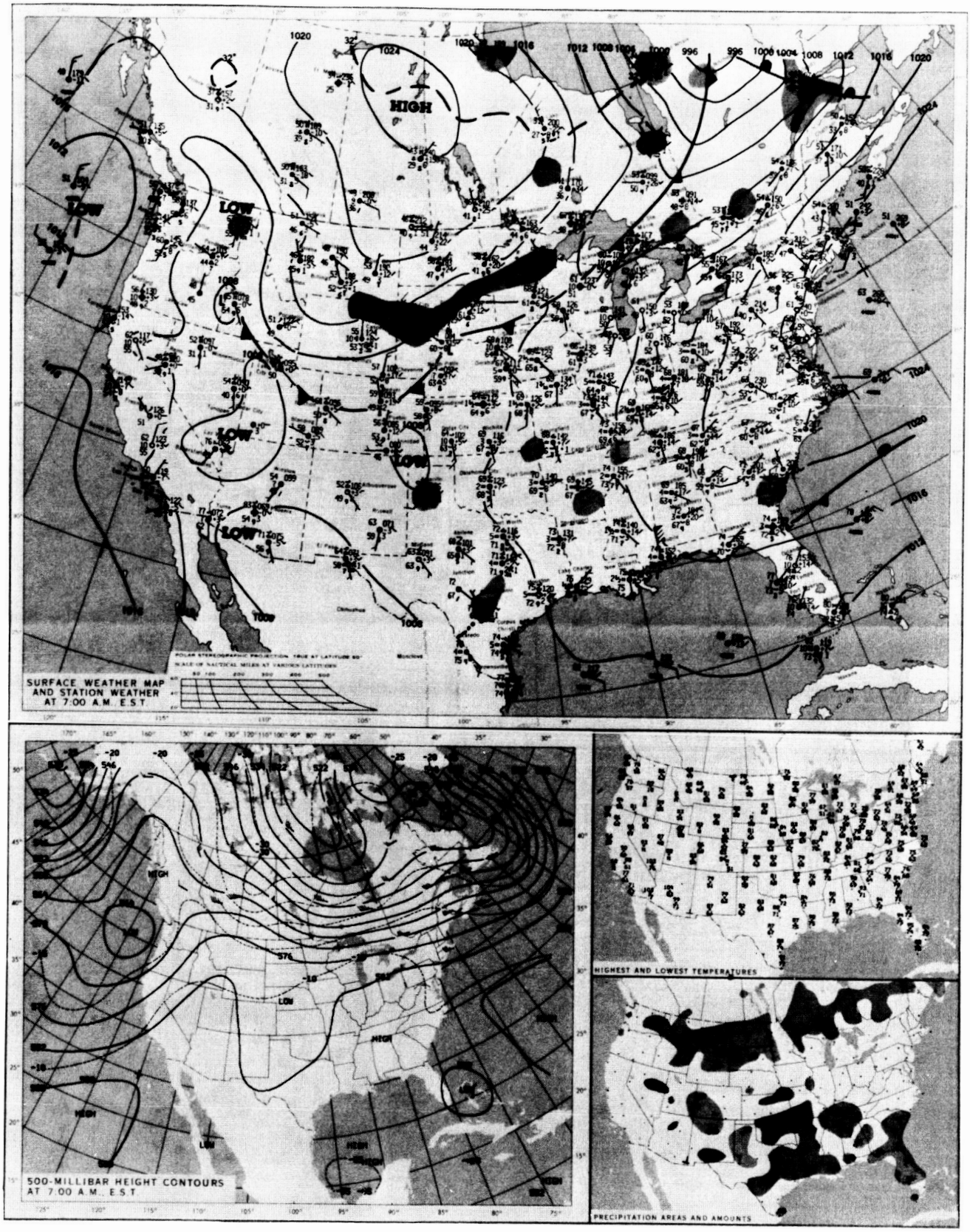


Fig. 3.2-3a. Synoptic weather conditions for 4 June 1986 1200 GMT

OPERATIONAL SUMMARY

4 June 1986

Rawinsonde Operations

The Meso-gamma network (3 stations only) was activated at 1800 and 2100 GMT. However, all shower activity had translated well to the northeast and was dissipating during this time interval. Additional soundings from RSA at 1200 GMT and the nearby NASA location at 1500 GMT should be representative of the early morning shower environment.

Radar Operations

The three available Doppler radars started operations at 1530-1600 GMT to gather data on nearby showers. CP-4 acquired the usual 6-min surveillance scan data, in addition to miscellaneous scans. Dual Doppler data were taken by CP-3 and CP-4 on the clear air PBL during the following time periods: 1600-1700, 1719-1725 and 1755-1801 GMT. Later on in the day, data were collected on a linear MCS from ~0200 to ~0500 GMT as it moved within the CP-4 maximum unambiguous range of 115 km. This system dissipated entirely over the west-central SPACE network near Muscle Shoals after 0500 GMT.

Satellite Operations

GOES VAS data were collected from the morning hours through 2200 GMT. RISOP was started at 2200 GMT and should capture the mature to dissipating stages of the early evening MCS.

Aircraft Operations

No operations.

Notes:

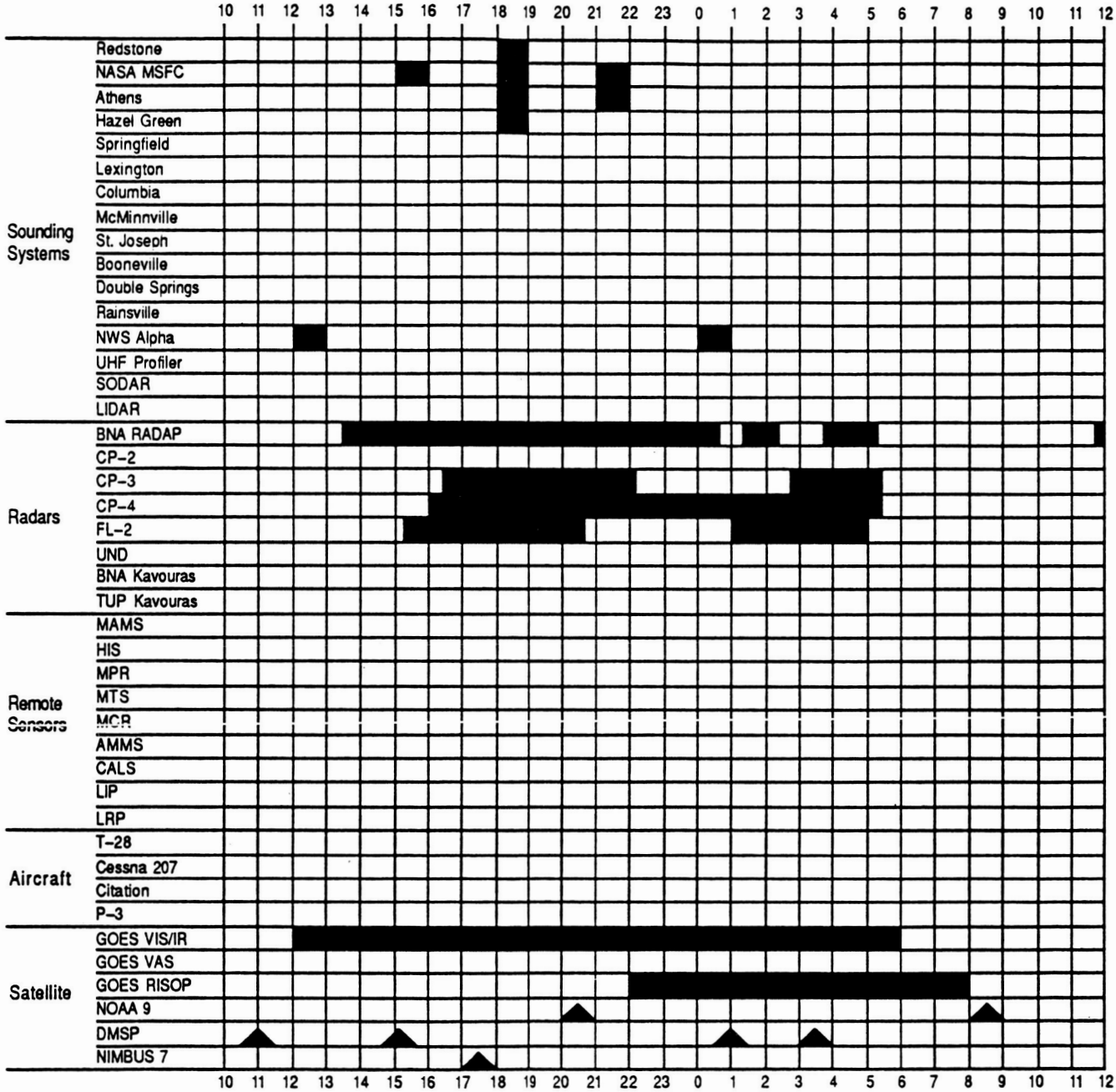
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5-550-7-8(03)

Day: WEDNESDAY
Date: 6/4/86
Julian Day: 155-156

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	MISSING STATION 9
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 6 & 9
	TVA ADAS	MISSING STATIONS 23 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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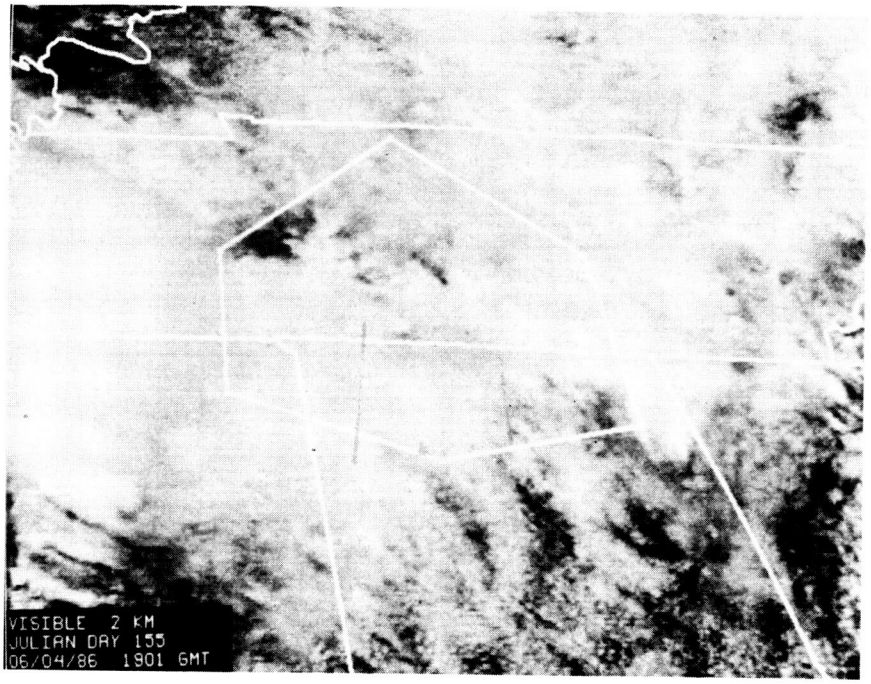


Fig. 3.2-3b. Visible 2 km GOES Central satellite image for 4 June 1986 1901 GMT

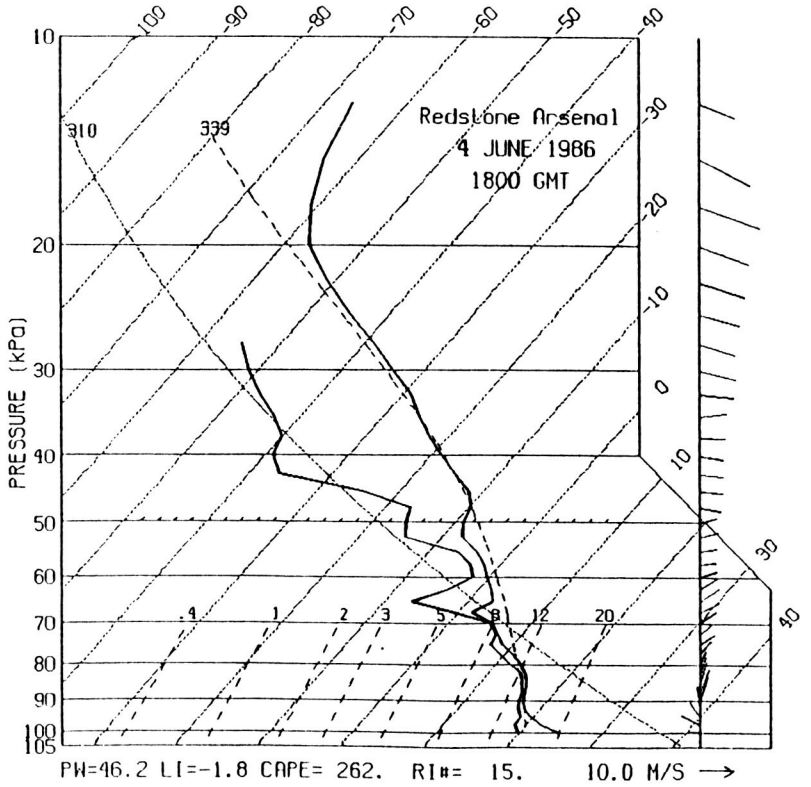


Fig. 3.2-3c. Redstone Arsenal, AL, rawinsonde sounding for 4 June 1986 1800 GMT

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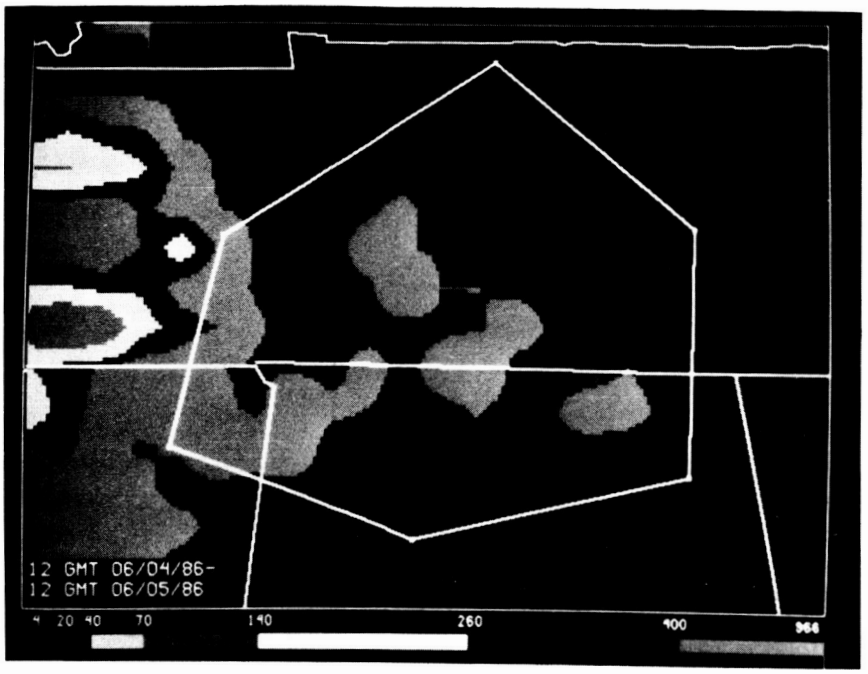


Fig. 3.2-3d. Twenty-four hour lightning strike density plot for 4-5 June 1986

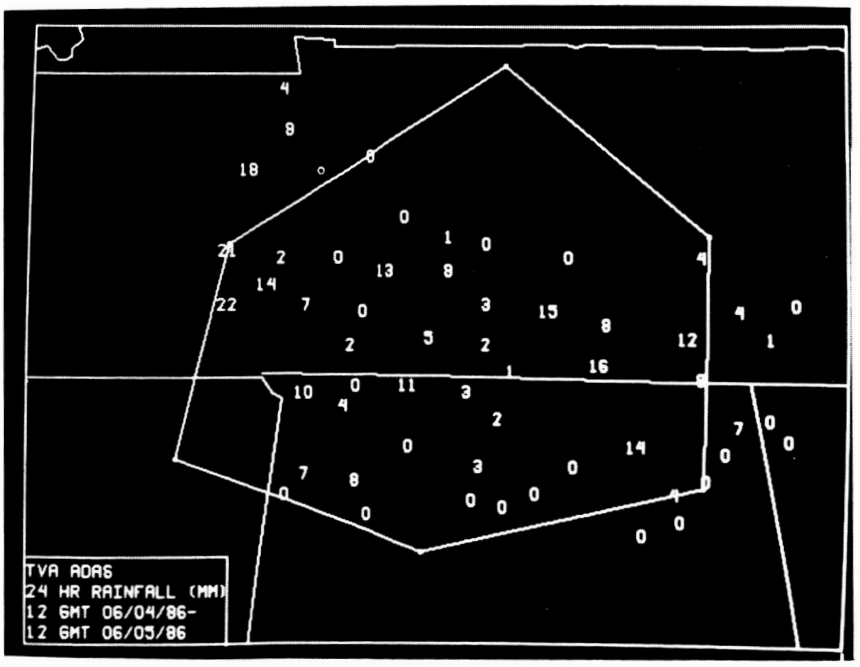


Fig. 3.2-3e. Twenty-four hour TVA ADAS rainfall totals (mm) for 4-5 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

5 June 1986

Synoptic Conditions

The surface high pressure ridge present over the region on the previous two days was less prominent today. A weak cold front remained well to the north of the SPACE mesonet during the day. Over the SPACE mesonet, very little horizontal variations in temperature were evident; afternoon surface temperature and dewpoint values were 27 and 21 °C. At upper levels, flow was primarily southwesterly above 600 mb, where an interesting shear region appears on the 1800 GMT RSA sounding. This environment is quite moist (49 mm precipitable water) but is not too unstable due to relatively cool surface temperatures. A weak short wave trough located over Oklahoma was expected to be influential over the SPACE network over the next two days.

Cloud/Precipitation Overview

An early morning stratus overcast dissipated by late morning, thus limiting maximum surface temperatures to 27-28 °C over the central beta network. Convection over the SPACE region was consequently limited to the western half, where a line of moderately intense convective cells developed over western Tennessee and into Kentucky by 1400 GMT. Total lightning counts from this activity were relatively small in number. At 1720 GMT the system covered the entire western beta network and was composed of active convective cores flanked by stratiform precipitation to the west. This convective activity eventually turned stratiform as the convective cells dissipated while the system moved eastward over the MIST/FLOWS network. A gust front associated with the system lingered for about two hours after the convection dissipated. Radar measurements of the lingering stratiform region were taken as the decaying system moved over the MIST/FLOWS network. During the remaining afternoon hours, convective activity over the beta network remained suppressed, apparently due to large scale subsidence associated with a weak surface high pressure ridge.

Notes:

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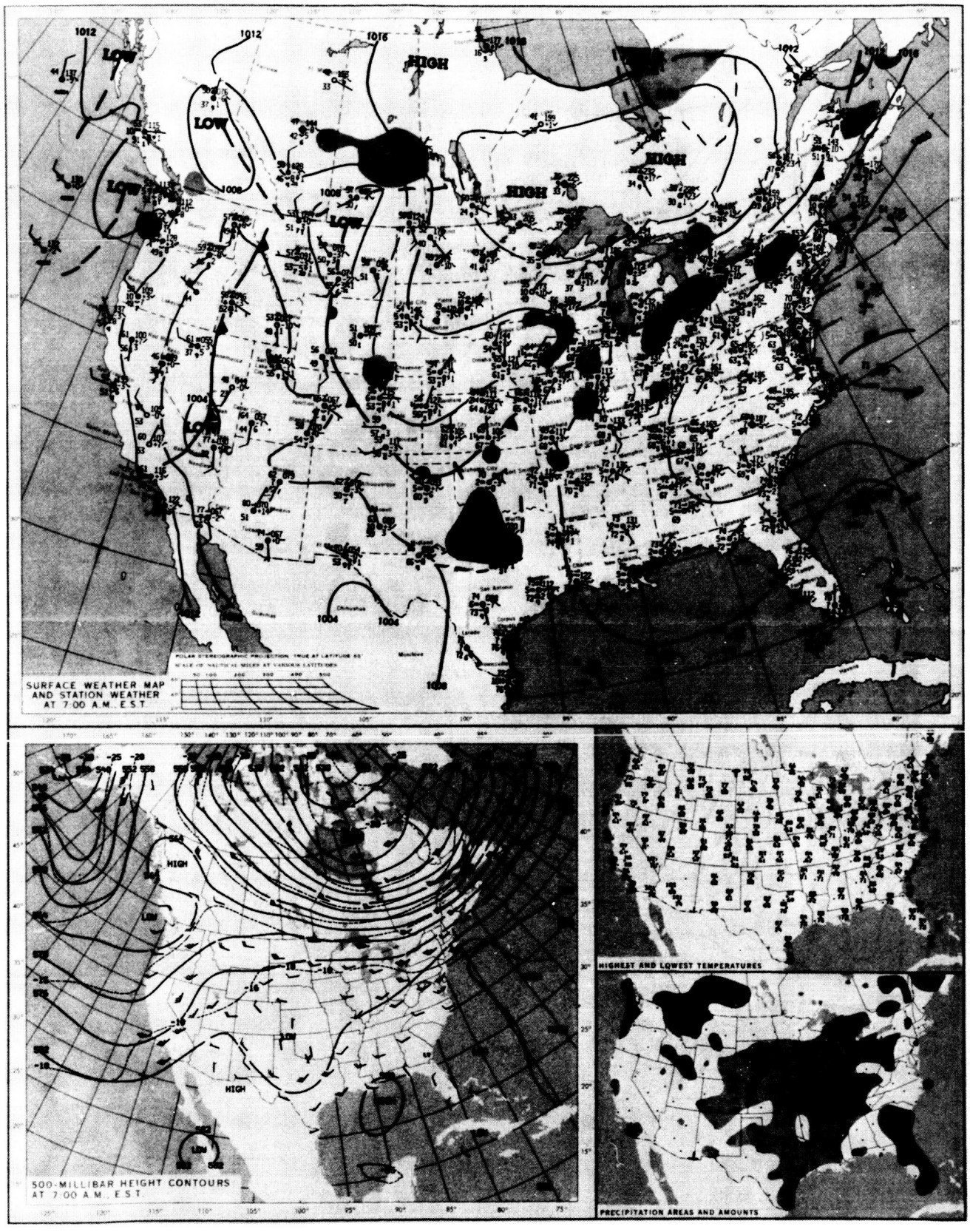


Fig. 3.2-4a. Synoptic weather conditions for 5 June 1986 1200 GMT

OPERATIONAL SUMMARY

5 June 1986

Rawinsonde Operations

Three stations forming a small triangle in the Meso-beta network were activated for 3-h soundings from 1800 to 0000 GMT. One station (Columbia) was inoperable at 1800 and 2100 GMT. Convection dissipated during the afternoon hours before entering the sounding region.

Radar Operations

CP-4 implemented primarily surveillance scans during its operational period. As the convective line approached the Doppler radars, some PPI sector data were acquired by CP-3, CP-4 and FL-2. CP-4 conducted VAD scans around 1930 GMT as the stratiform precipitation moved over the MIST/FLOWS network. The BNA RADAP disk controller malfunctioned near 1730 GMT, and RADAP was down thereafter.

Satellite Operations

VAS products are available for only seven times prior to 1900 GMT. RISOP was called at 2000 GMT, a time following all significant convection over the beta network.

Aircraft Operations

No operations.

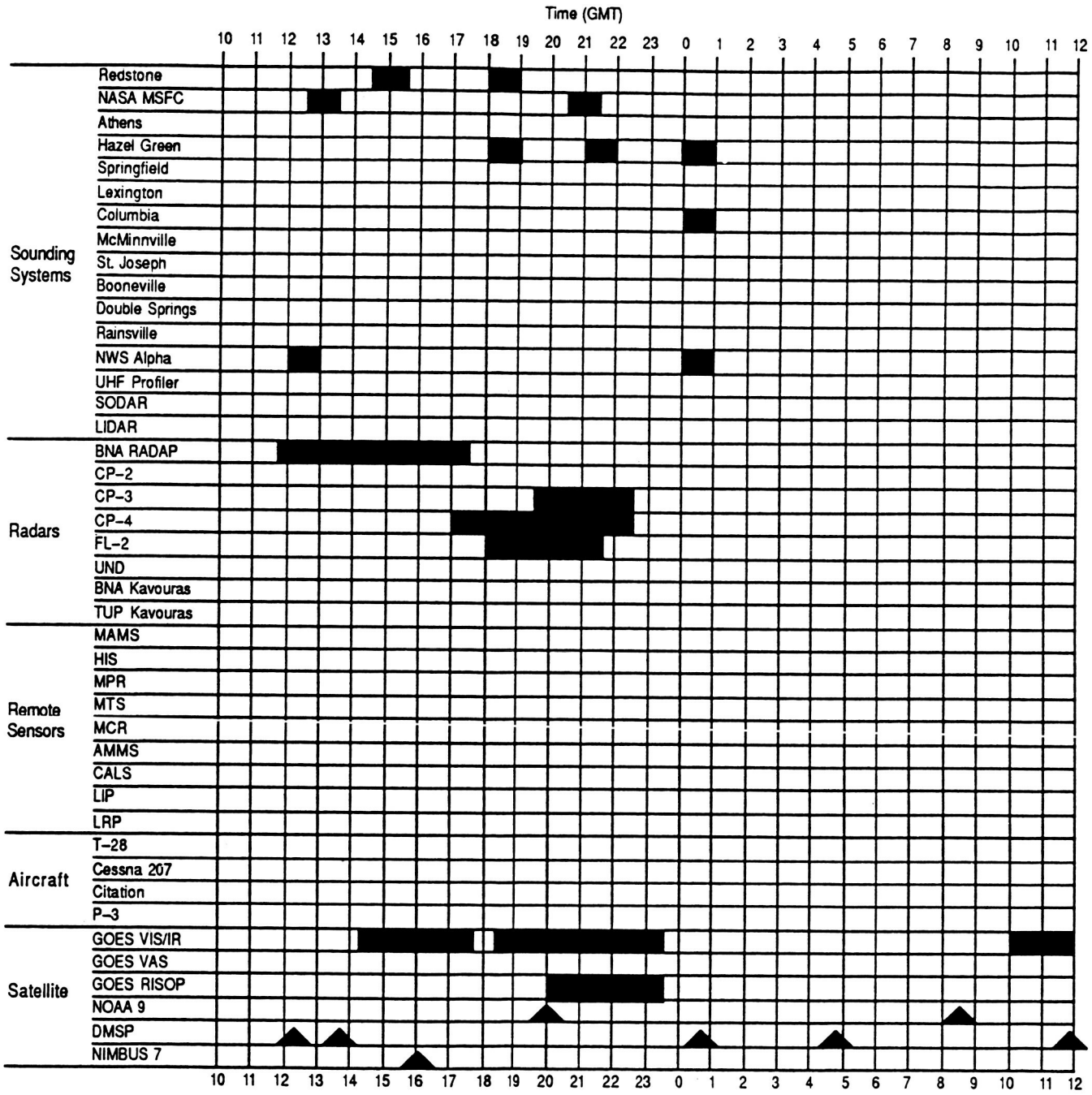
Notes:

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Day: THURSDAY
Date: 6/5/86
Julian Day: 156–157

Hourly Collection of COHMEX Data



		Comments
Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 6
	TVA ADAS	MISSING STATIONS 23, 25, 45 & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

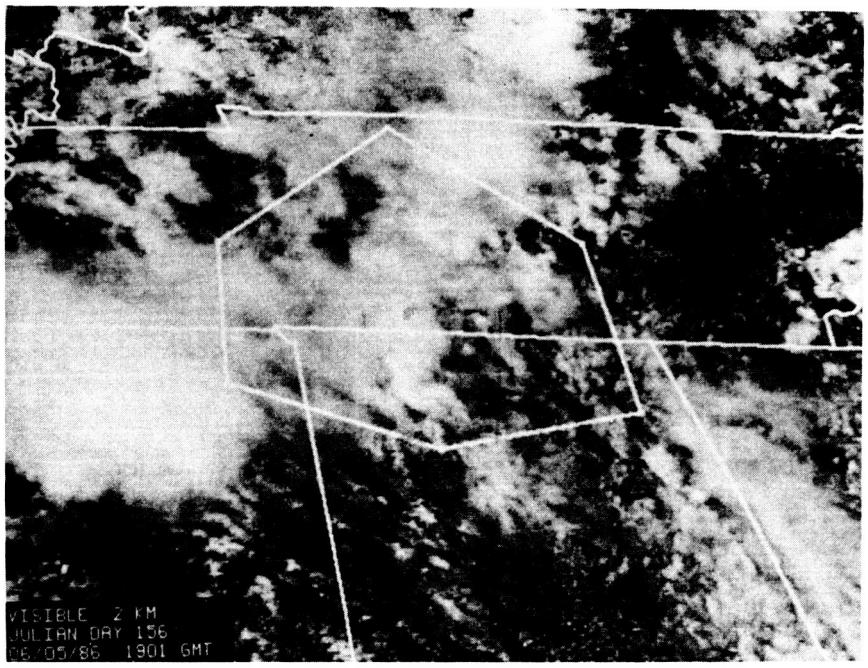
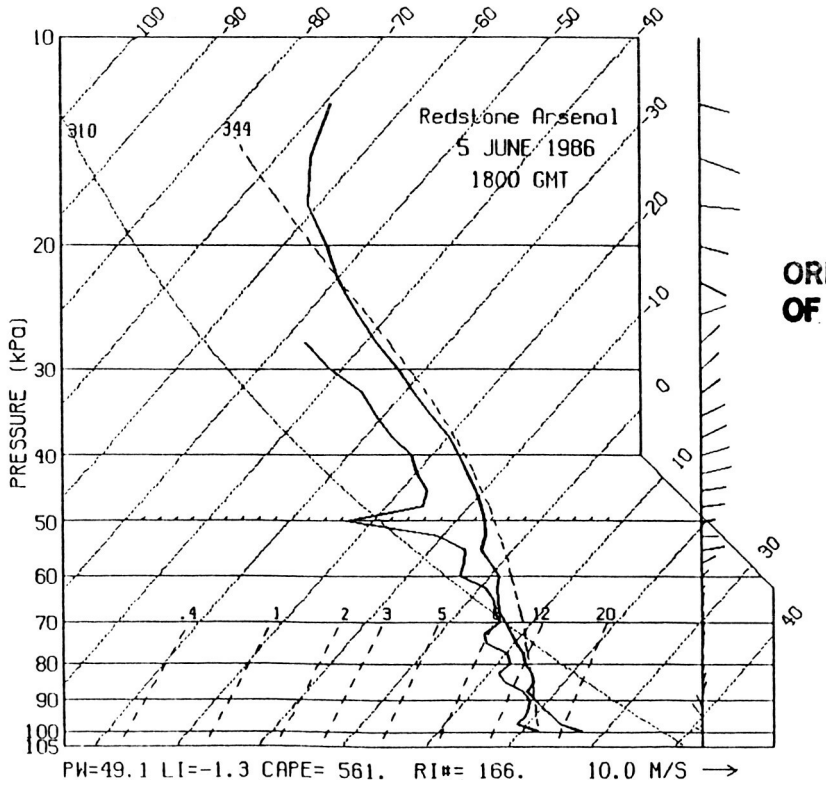


Fig. 3.2-4b. Visible 2 km GOES Central satellite image for 5 June 1986 1901 GMT



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Fig. 3.2-4c. Redstone Arsenal, AL, rawinsonde sounding for 5 June 1986 1800 GMT

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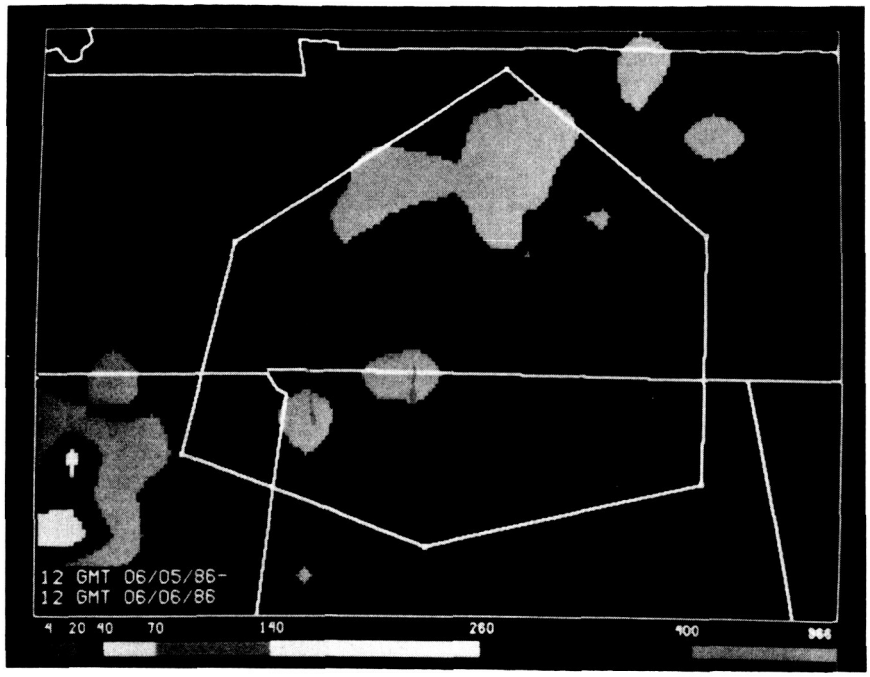


Fig. 3.2-4d. Twenty-four hour lightning strike density plot for 5-6 June 1986

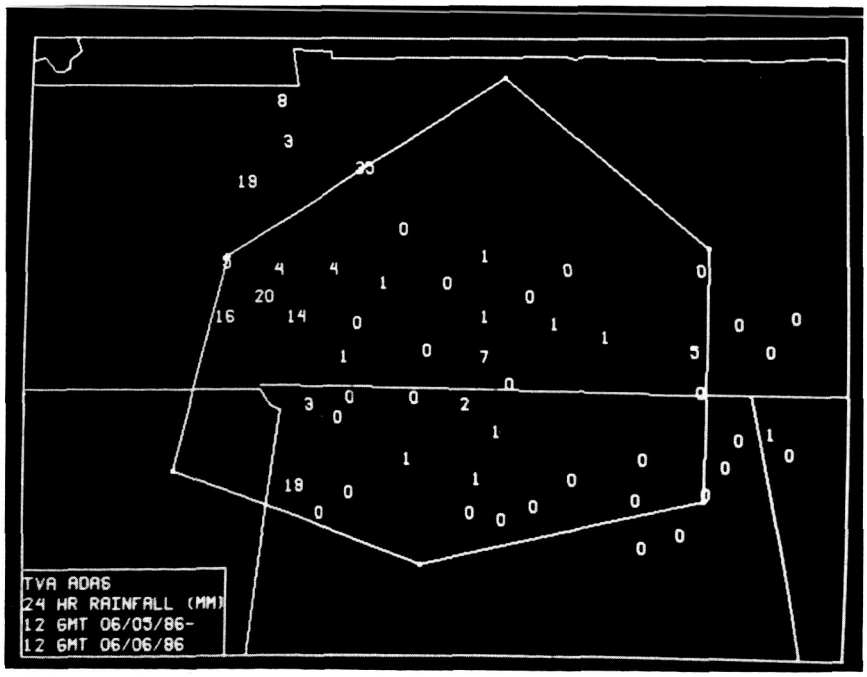


Fig. 3.2-4e. Twenty-four hour TVA ADAS rainfall totals (mm) for 5-6 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

6 June 1986

Synoptic Conditions

Upper level flow over the Southeast U.S. remained light (5-10 m s^{-1}) and generally west to southwesterly during the day. The upper level trough visible yesterday progressed slowly eastward, having moved over Arkansas by the day's end. The atmosphere over the SPACE mesonet was more unstable, and total precipitable water remained high throughout. At the surface, an east-west oriented stationary front remained north of the SPACE mesonet. Afternoon surface temperature and dewpoint values over the SPACE mesonet were ~27 and ~21 °C. The ridge of high pressure noted on previous days persisted over the network in weakened form during the entire day.

Cloud/Precipitation Overview

A well defined linear MCS (oriented north to south) formed over northern Mississippi around 1200 GMT and moved eastward over the beta network over the next nine hours. As the MCS moved over the network at 1900 GMT, the individual cells within the line merged to form a solid precipitation band having a convective leading edge and a trailing stratiform region. This transformation was accompanied by a pronounced inflow in to the rear of the line near the 2-4 km level. Subsequently, two mesocyclones formed, each associated with initially intense convective echoes. Maximum velocity differential was 20-30 m s^{-1}, and cyclonic shear remained for about one hour. The maximum cirrus cloud shield occurred around 2000-2100 GMT, after which the MCS weakened and turned stratiform over the central beta network just west of the MIST/FLOWS network. Associated lightning activity was moderately low and precipitation totals were generally less than 15 mm, except over the southwestern SPACE mesonet (see Fig. 3.2-5e). Some wind associated surface damage was reported over the western mesonet.

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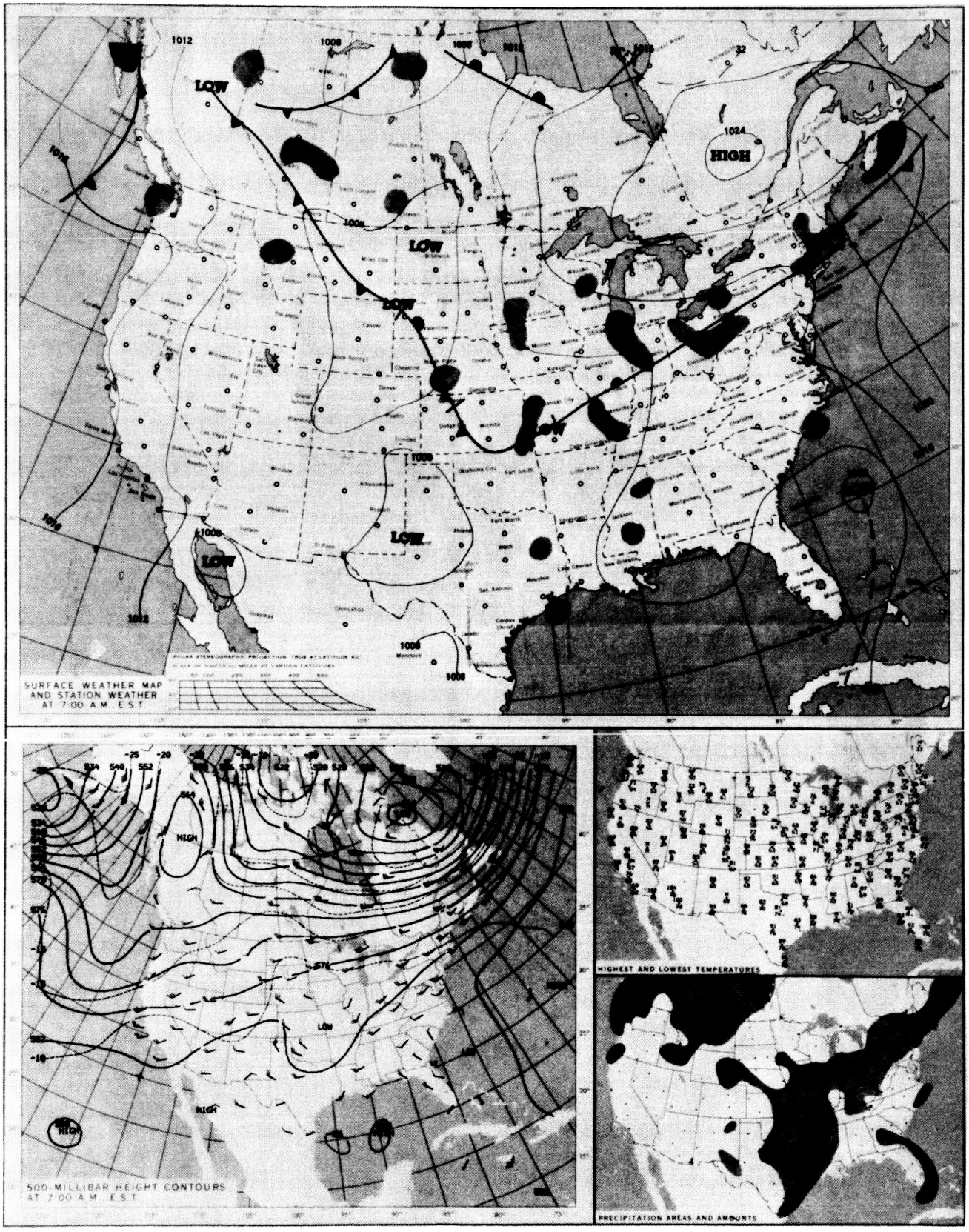


Fig. 3.2-5a. Synoptic weather conditions for 6 June 1986 1200 GMT

OPERATIONAL SUMMARY

6 June 1986

Rawinsonde Operations

An 8 station Meso-beta rawinsonde operation was run at 3-h intervals from 1500 to 0300 GMT. Lexington was down throughout this period, and McMinnville had miscellaneous problems throughout. However, the stations within the path of the most intense portion of the MCS appear to have collected a complete set of data. In addition to the Meso-beta soundings, the adjacent NWS sites released soundings at 3-h intervals from 1200 to 0600 GMT.

Radar Operations

CP-3 and CP-4 acquired some dual Doppler data on the gust front associated with the decaying MCS. Miscellaneous scans were conducted otherwise. The latter developing, mature and dissipating stages of the MCS appear to be well covered in single mode by Doppler radar. As the stratiform precipitation moved over the MIST/FLOWS network from 2030 to 2130 GMT, VAD scans were effected by CP-4, and some by CP-3. Both CP-2 and RADAP were down. FL-2 collected 3.5 hours of data on the approaching MCS, acquiring both PPIs and RHIs through the leading gust front. The gust front exhibited a convergent wind shear up to 24 m s^{-1} and was apparent as a wind shift over the lowest 3 km. One gust frontal system and one microburst were logged by FL-2 personnel.

Satellite Operations

GOES satellite operations were normal through 0000 GMT, after which RISOP was started. Thus, the entire MCS cycle was under the normal 30-min coverage, and VAS products may be useful both in advance of and behind the line.

Aircraft Operations

No operations.

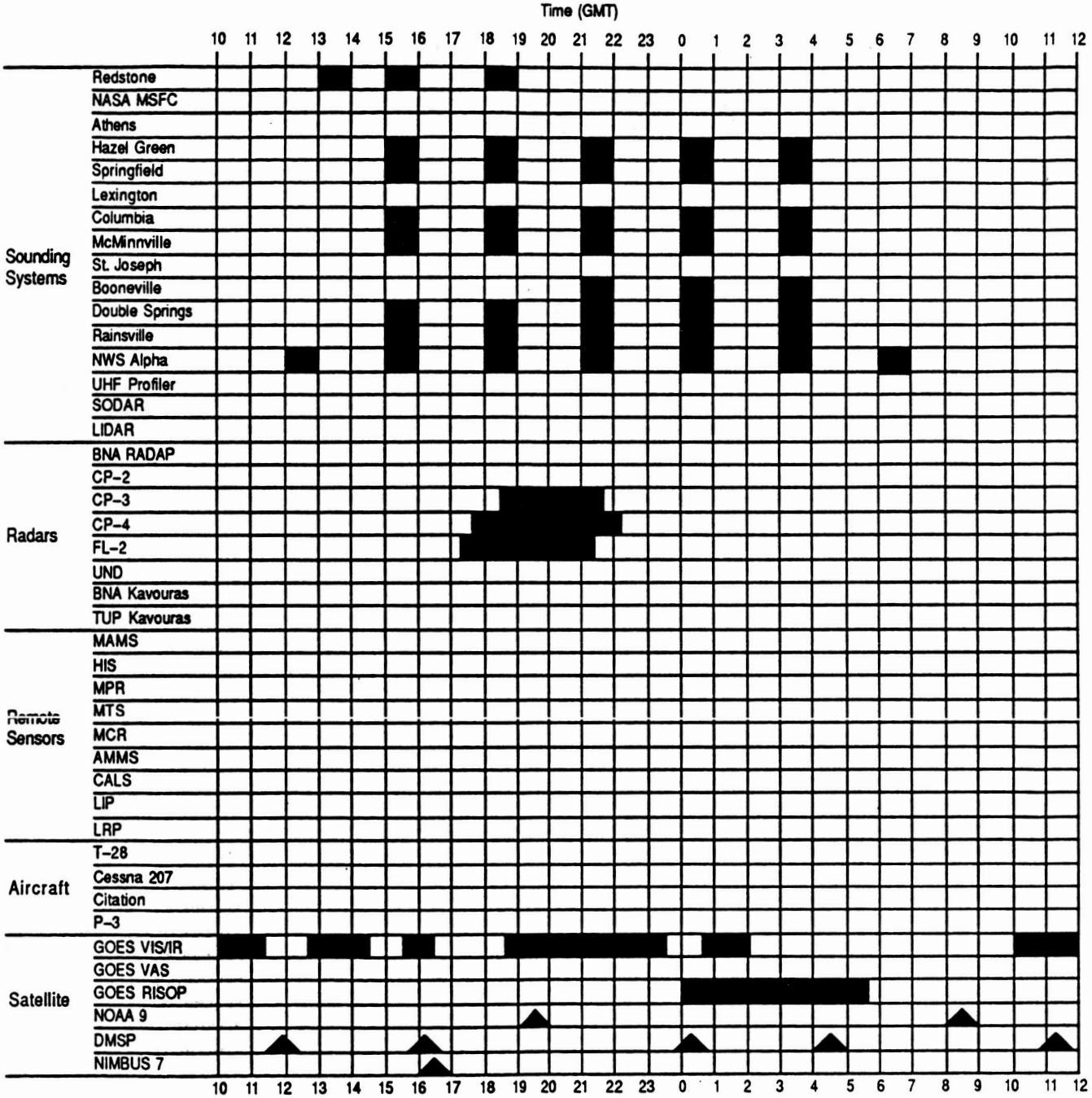
Notes:

5-550-7-8(05)

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Day: FRIDAY
Date: 6/6/86
Julian Day: 157-158

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 4
	TVA ADAS	MISSING STATIONS 23, 25, 27, 32, 40, 45 & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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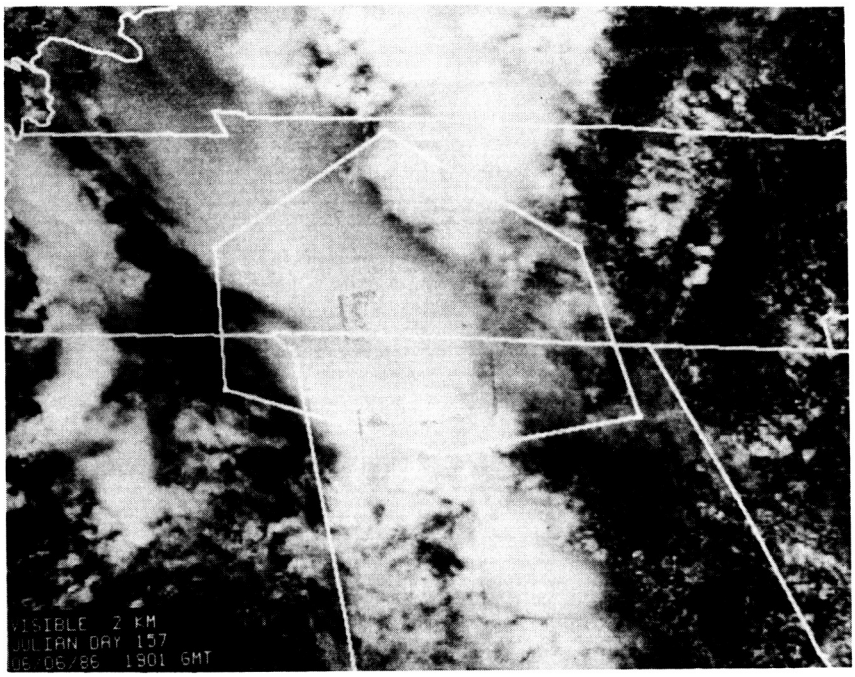


Fig. 3.2-5b. Visible 2 km GOES Central satellite image for 6 June 1986 1901 GMT

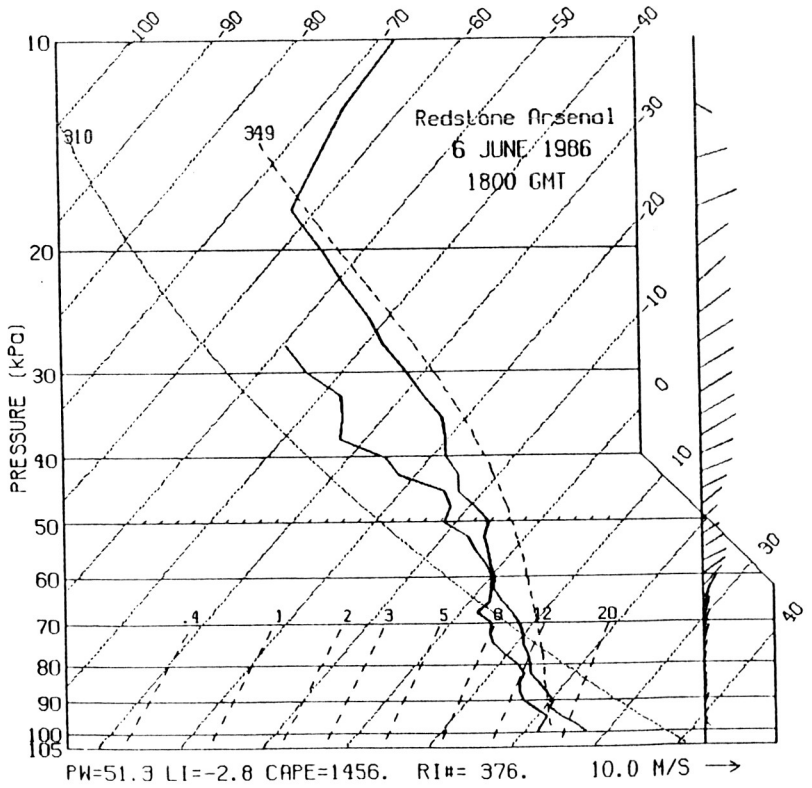


Fig. 3.2-5c. Redstone Arsenal, AL, rawinsonde sounding for 6 June 1986 1800 GMT

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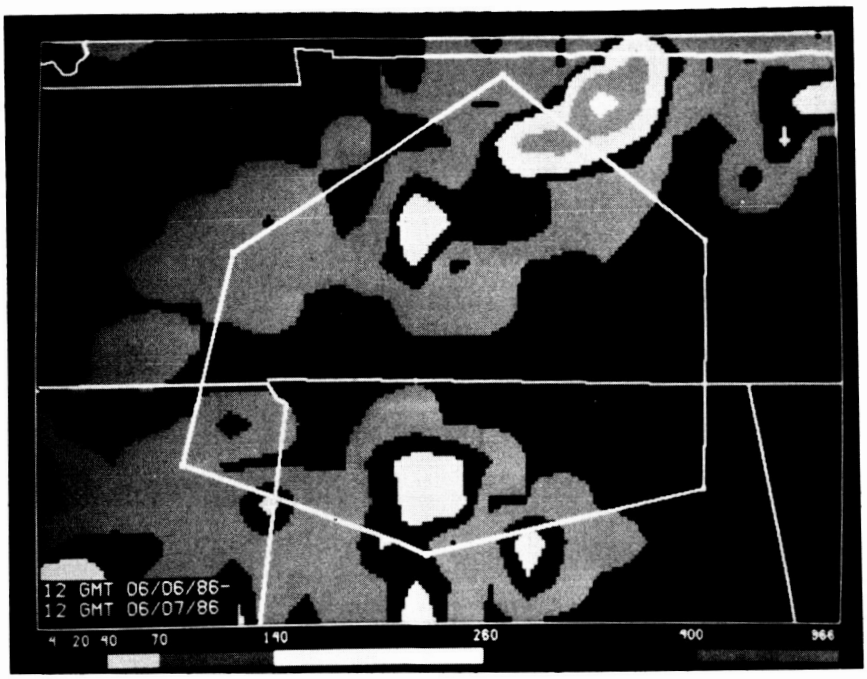


Fig. 3.2-5d. Twenty-four hour lightning strike density plot for 6-7 June 1986

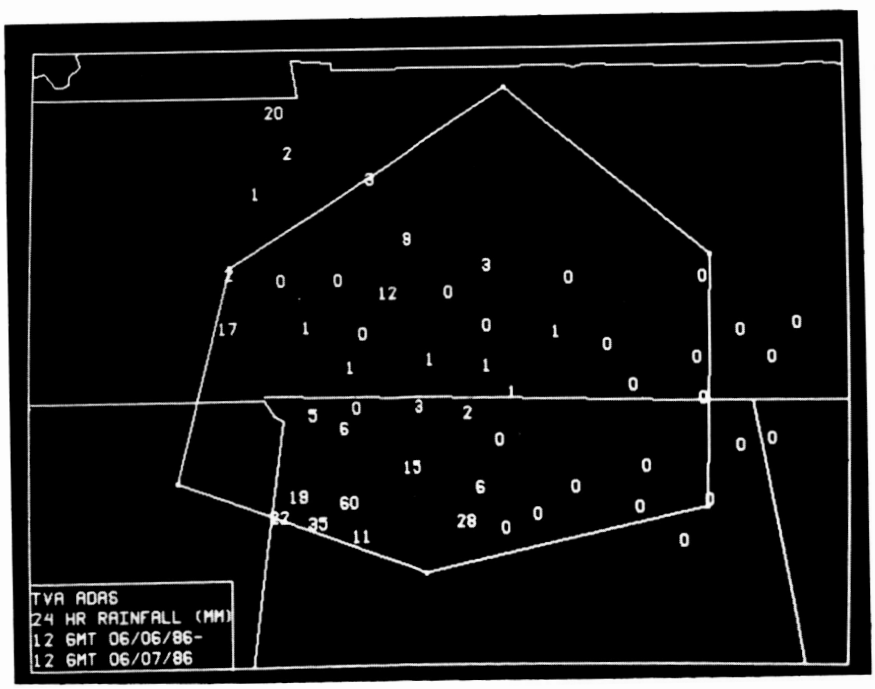


Fig. 3.2-5e. Twenty-four hour TVA ADAS rainfall totals (mm) for 6-7 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

7 June 1986

Synoptic Conditions

The surface based high pressure ridge visible on previous days over the SPACE region was no longer significant. Surface features were generally uniform over the SPACE mesonet; afternoon temperature and dewpoint values were 26-28 °C and 21-23 °C. Above the surface, flow was primarily west to southwesterly and much stronger at lower midlevels than on previous days. A weak short wave trough moved over the mesonet during the day. Abundant moisture (precipitable water to ~50 mm) was again common over the entire southeastern region.

Cloud/Precipitation Overview

Deep convection was scattered over the entire beta network throughout the late morning to afternoon hours. Two periods of thunderstorm activity affected the MIST/FLOWS network. Initial clouds formed explosively around 1700 GMT near CP-3, and then moved just south of CP-4. This activity produced locally heavy rainfall (to 37 mm) and several microbursts (maximum gust to 23 m s^{-1}) over the MIST/FLOWS network. FLOWS personnel logged four microbursts out of several cells. A second precipitation event translated into the MIST/FLOWS network later around 2000 GMT. This system formed in northeastern Mississippi during the late morning hours and managed to remain active before dissipating just west of the Doppler radars. Stratiform precipitation (~30 dBZ echo intensity) lingered over the MIST/FLOWS network as the system weakened. Over the SPACE mesonet, relatively intense convection was scattered during the afternoon hours, and apparently widespread over the northern half after 0000 GMT. Precipitation amounts were moderately high (>20 mm) over portions of the network. Once again, thunderstorms were present near sunrise.

Notes:

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7 June 1986

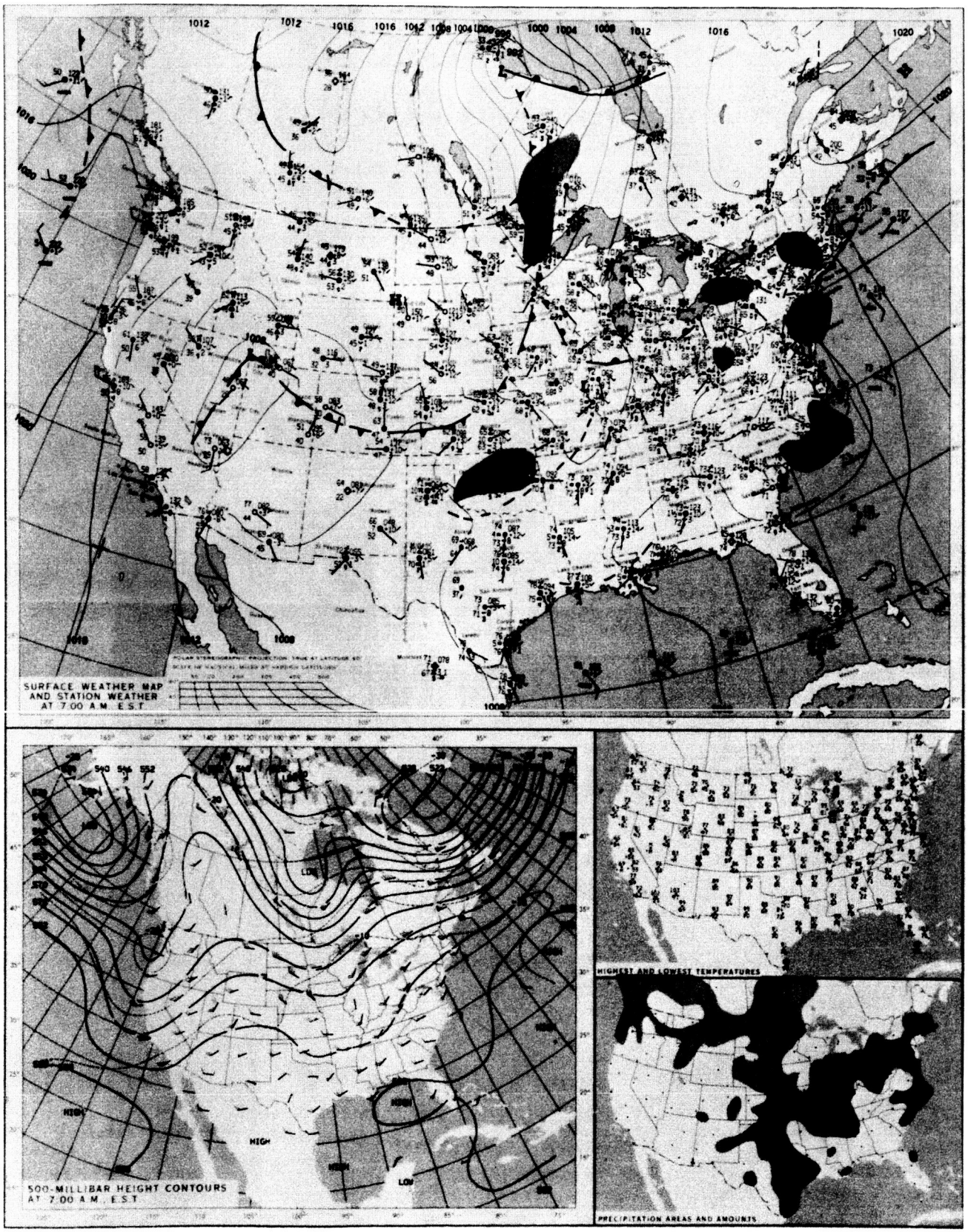


Fig. 3.2-6a. Synoptic weather conditions for 7 June 1986 1200 GMT

OPERATIONAL SUMMARY

7 June 1986

Rawinsonde Operations

Special soundings were acquired from RSA at 1200 and 1800 GMT. The 1800 GMT sounding should be representative of the environment supporting intense convection in the vicinity near this time.

Radar Operations

During the late morning activity, primarily RHIs were collected by CP-3 and CP-4. Miscellaneous surveillance scans and sector scans were taken on afternoon activity.

Satellite Operations

Normal operations.

Aircraft Operations

No operations.

Notes:

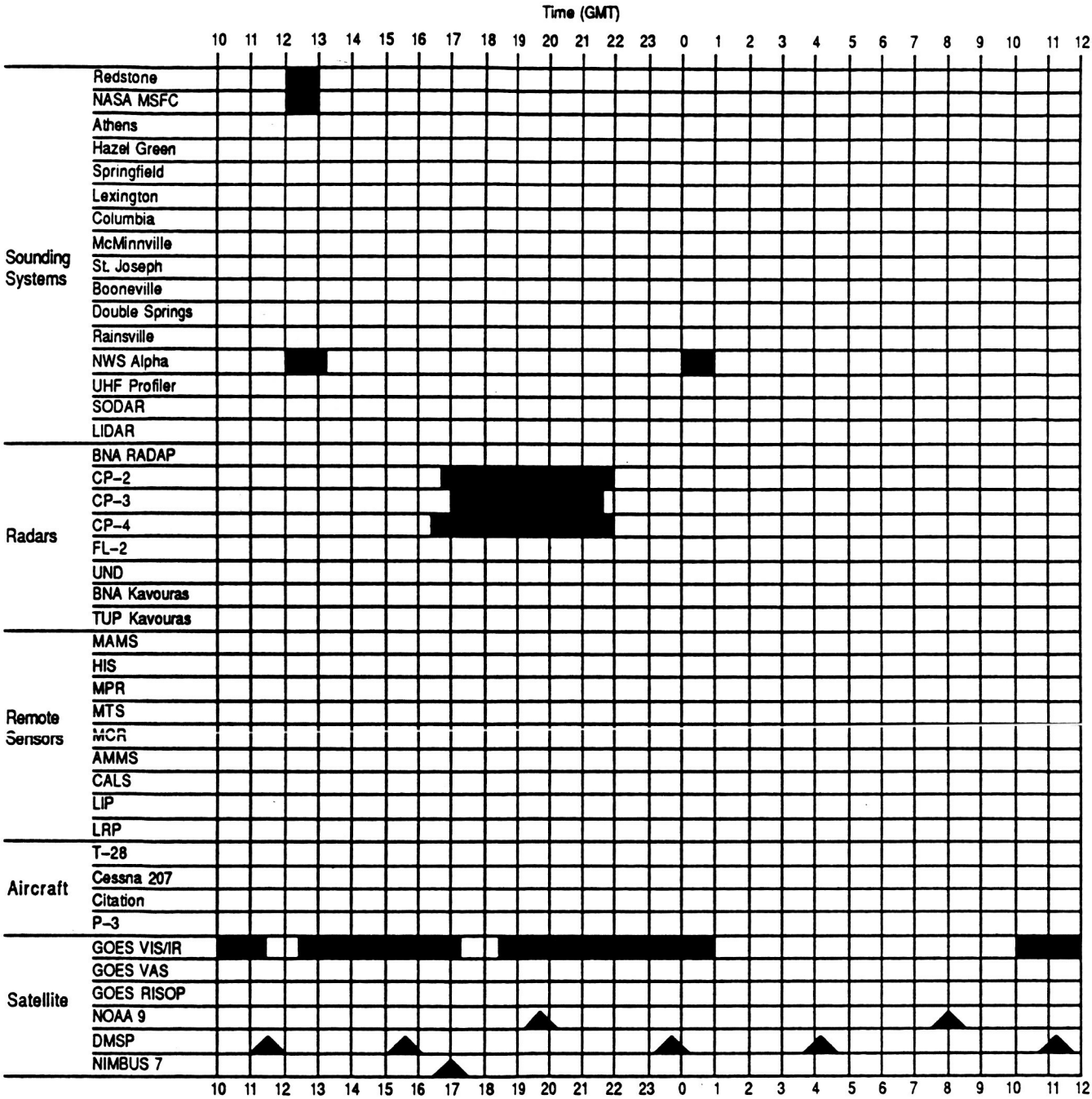
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5-550-7-8(06)

Day: SATURDAY
Date: 6/7/86
Julian Day: 158–159

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 4
	TVA ADAS	MISSING STATIONS 23, 25, 32, 40, 45 & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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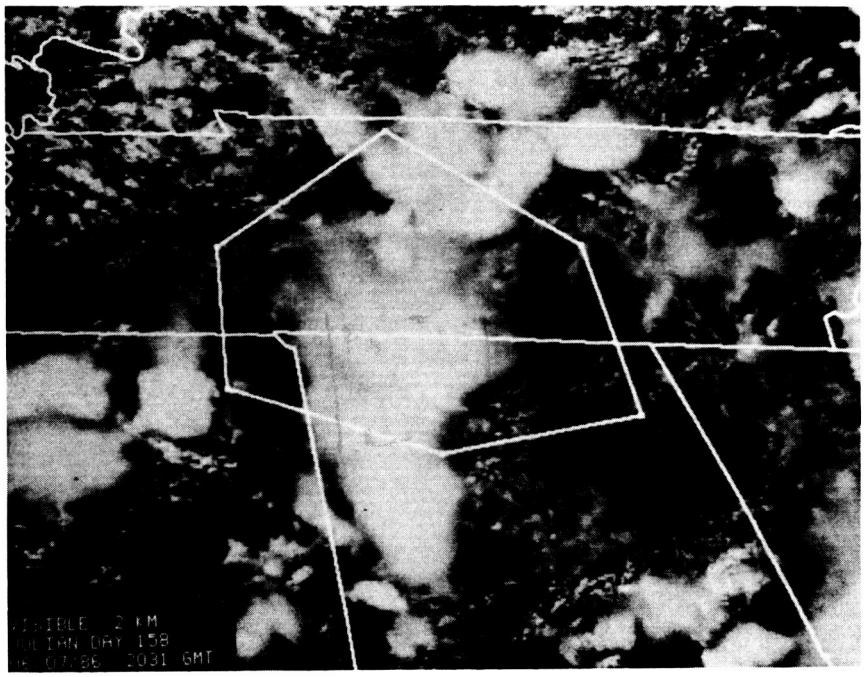


Fig. 3.2-6b. Visible 2 km GOES Central satellite image for 7 June 1986 2031 GMT

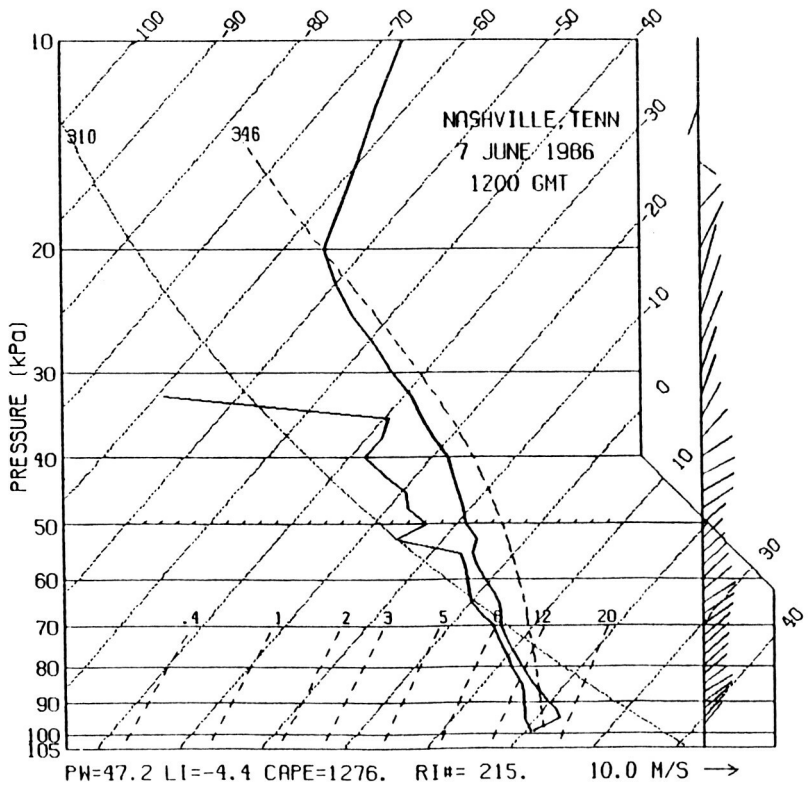


Fig. 3.2-6c. Nashville, TN, rawinsonde sounding for 7 June 1986 1200 GMT

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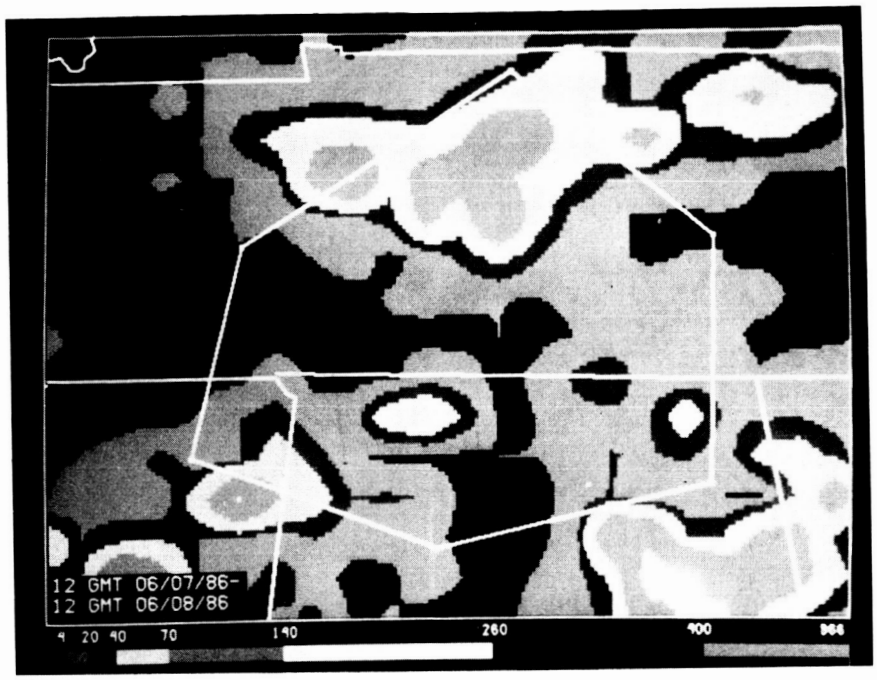


Fig. 3.2-6d. Twenty-four hour lightning strike density plot for 7-8 June 1986

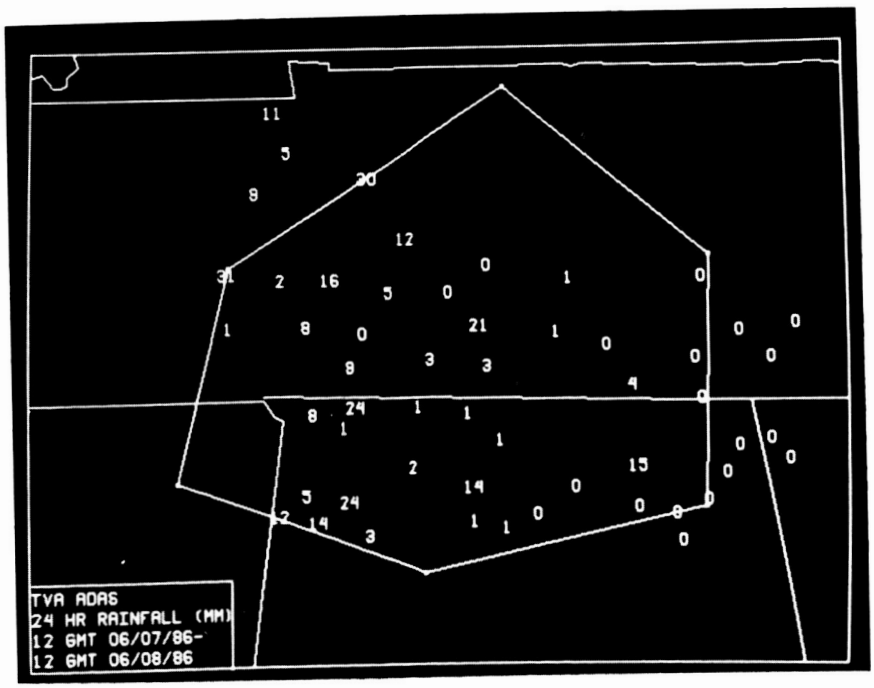


Fig. 3.2-6e. Twenty-four hour TVA ADAS rainfall totals (mm) for 7-8 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

8 June 1986

Synoptic Conditions

Large scale conditions were similar to those observed yesterday. Measured precipitable water (54 mm) remained very high, but upper level wind magnitudes (4-8 m s^{-1}) were somewhat less than yesterday's values, and appeared to decrease during the day. Total convective available potential energy on the 1800 GMT local sounding increased appreciably over yesterday's value. A weak surface trough oriented southwest to northeast was located along the northern edge of the SPACE mesonet just in advance of a slowly moving cold front that turned stationary and remained north of the mesonet during the day. Surface temperature and dewpoint values over the SPACE mesonet were 28-30 and 21-23 °C in the presence of west to southwesterly surface flow of 2-4 m s^{-1}.

Cloud/Precipitation Overview

Scattered, intense thunderstorm activity was common over much of the SPACE mesonet from late morning throughout the afternoon hours. Initial thunderstorms formed by 1800 GMT north of the MIST/FLOWS network over the central beta network, and south of the MIST/FLOWS network over central Alabama. Subsequent convection over the MIST/FLOWS network grew explosively as larger scale outflow boundaries emanating from the previous convective regions merged over and near the MIST/FLOWS network. Outflow boundaries in general appeared to be quite effective in producing secondary convection on this day. Convective activity over and near the MIST/FLOWS network produced heavy rainfall (in excess of 50 mm at some stations) and several microbursts. Local thunderstorm activity eventually coalesced upon weakening to form a relatively homogeneous area of stratiform precipitation which formed near 2330 GMT and persisted until ~0200 GMT.

Over the Meso-beta network rainfall was also locally heavy (several amounts >30 mm) and outflow winds were common and strong (up to 20 m s^{-1}).

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8 June 1986

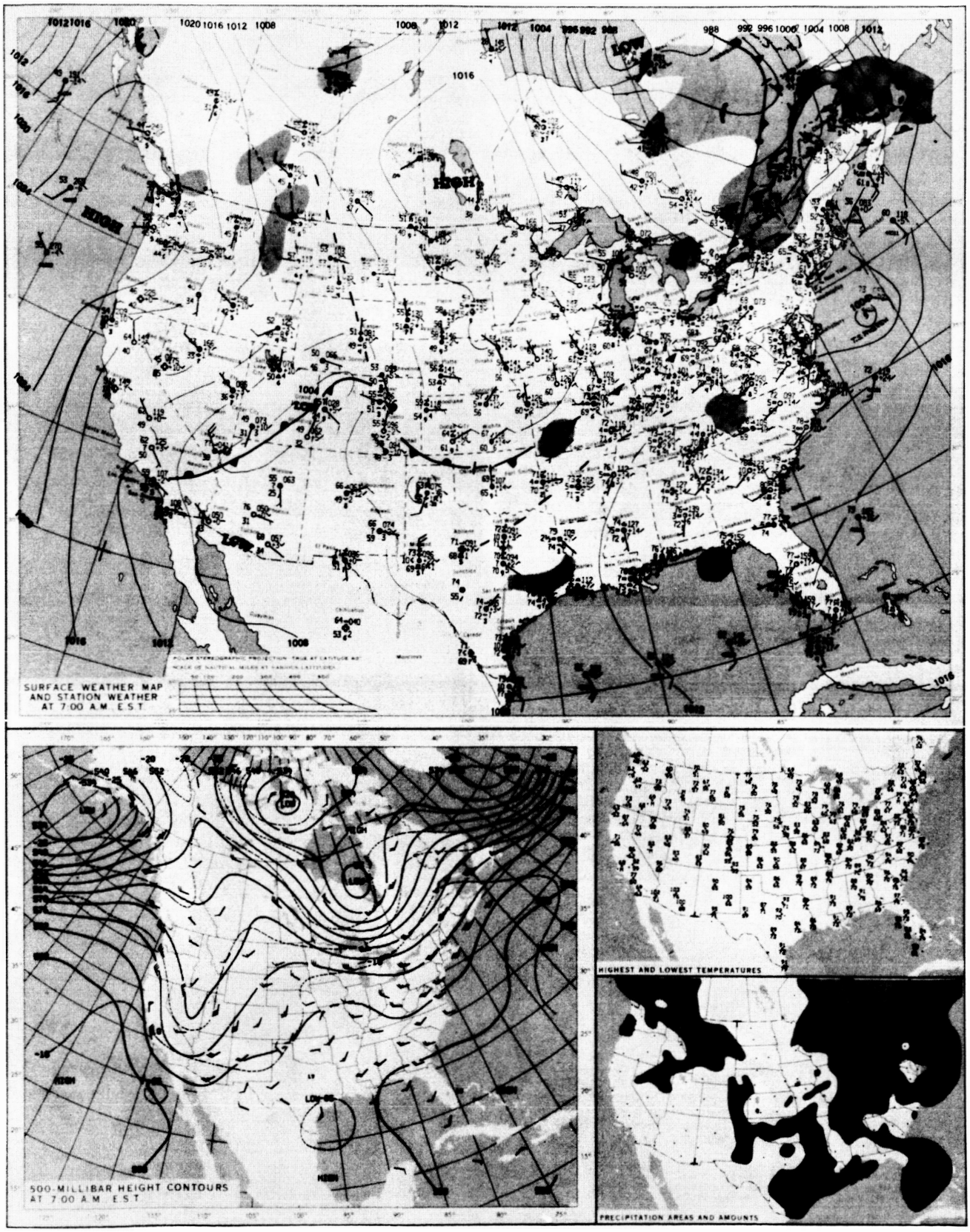


Fig. 3.2-7a. Synoptic weather conditions for 8 June 1986 1200 GMT

OPERATIONAL SUMMARY

8 June 1986

Rawinsonde Operations

Serial soundings were taken from the NASA Atmospheric Research Facility at 1800, 2100 and 0000 GMT. These should provide valuable data on the rapidly developing mesoscale environment. In addition, the normal 1200 GMT RSA sounding is available.

Radar Operations

CP-3 and CP-4 conducted miscellaneous scans throughout the afternoon. Dual Doppler scans were accomplished in both the southeast and northwest lobes. CP-4 provided the 6-min surveillance scans as usual, and also conducted VAD scans within stratiform precipitation from 2347 to 0019 GMT. FL-2 was down from 1900 to 2200 GMT due to air conditioning problems. After 2200 GMT, FL-2 personnel noted several microbursts associated with strong cells (60 - 65 dBZ) over and near the MIST/FLOWS network. RADAP remained inoperational all day because of continued hardware problems.

Satellite Operations

RISOP was started at 1830 GMT and should have captured the intensification of storms over the beta network. Prior to this, VAS products were generated. These may provide valuable soundings in relatively clear regions where deep convection later formed.

Aircraft Operations

No operations.

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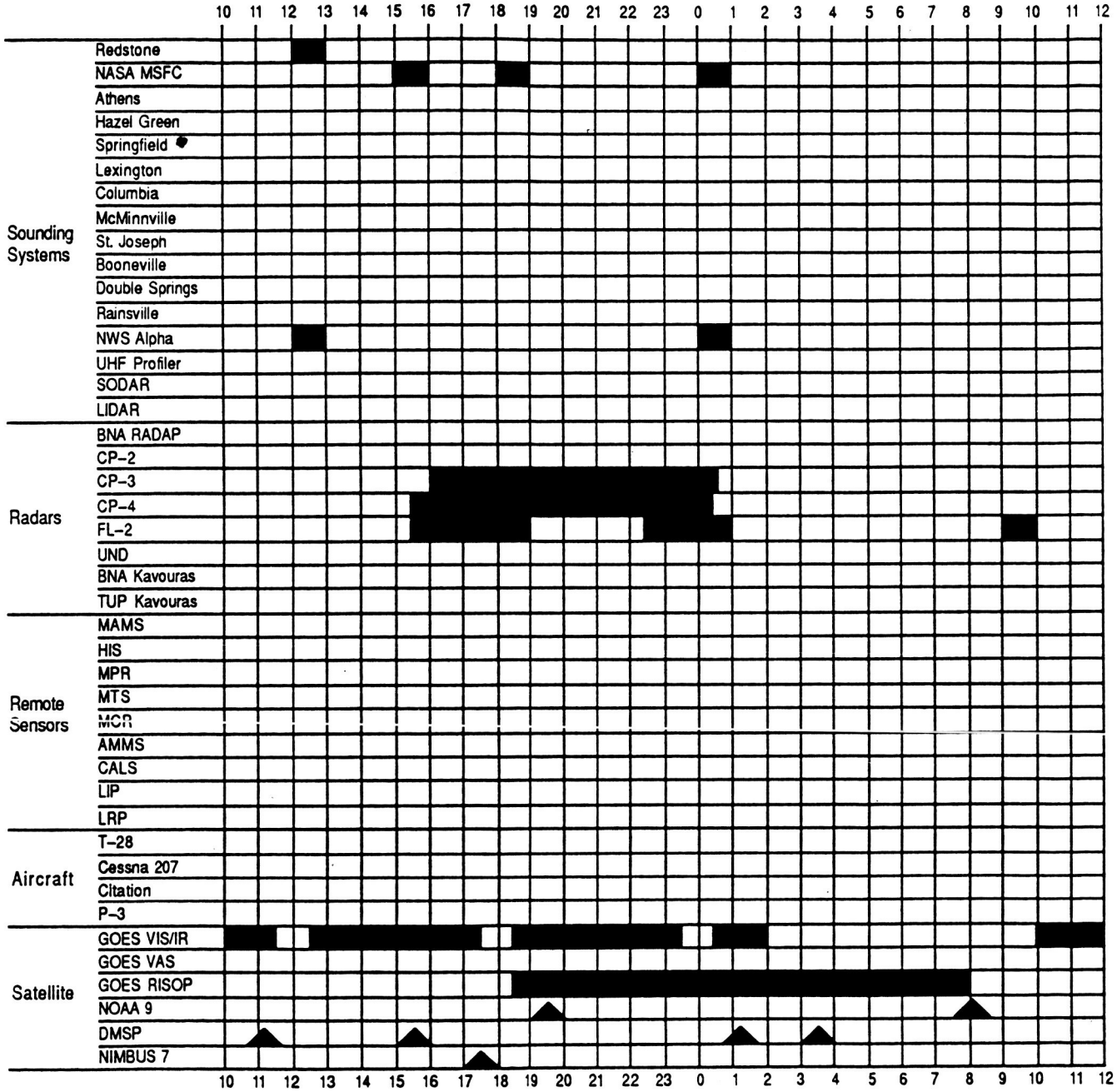
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Day: SUNDAY
Date: 6/8/86
Julian Day:- 159-160

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 7
	TVA ADAS	MISSING STATIONS 23, 25, 29, 32, 45, & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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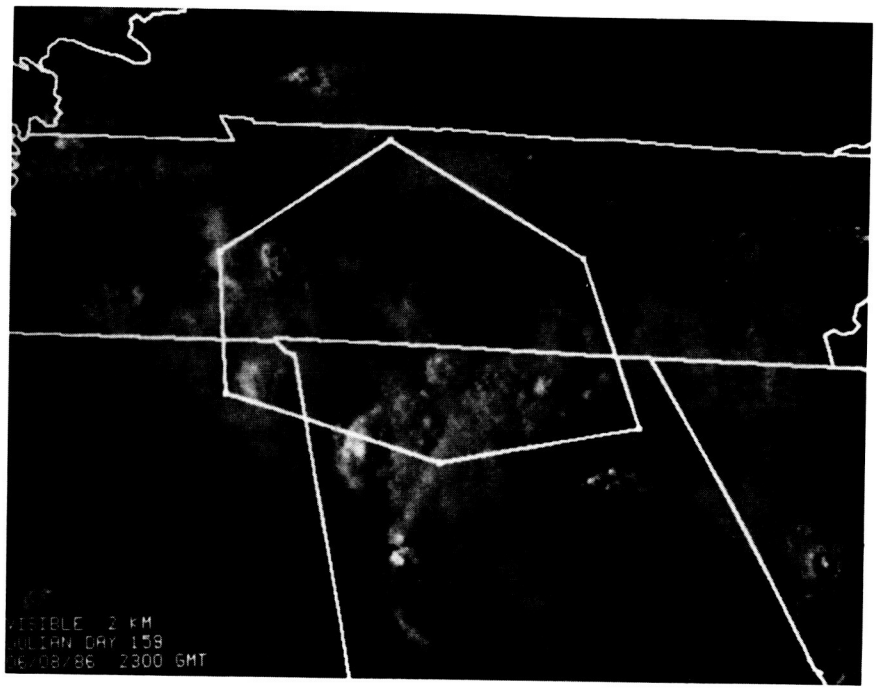


Fig. 3.2-7b. Visible 2 km GOES Central satellite image for 8 June 1986 2300 GMT

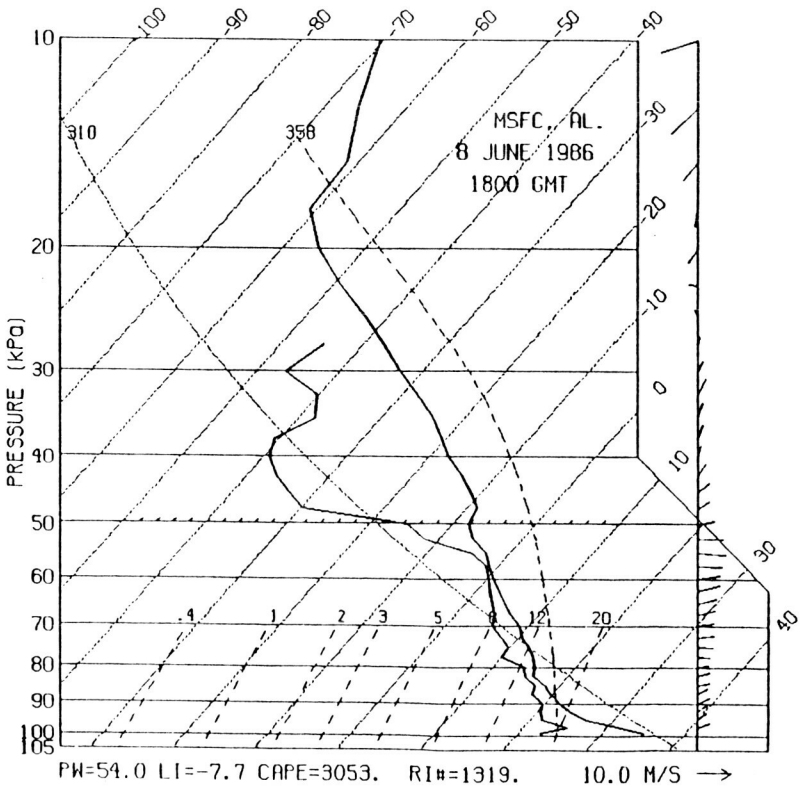


Fig. 3.2-7c. MSFC, AL, rawinsonde sounding for 8 June 1986 1800 GMT

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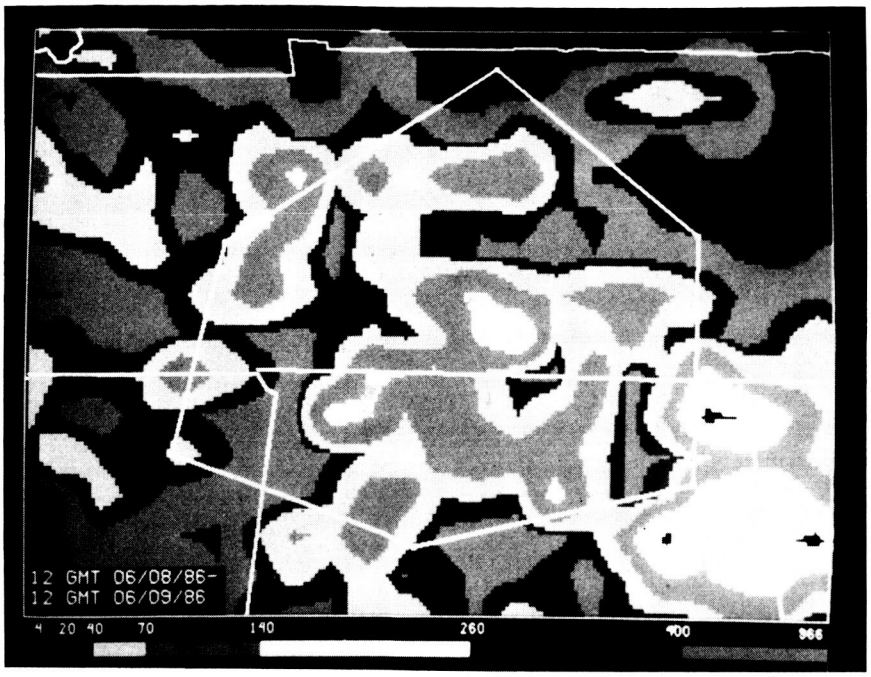


Fig. 3.2-7d. Twenty-four hour lightning strike density plot for 8-9 June 1986

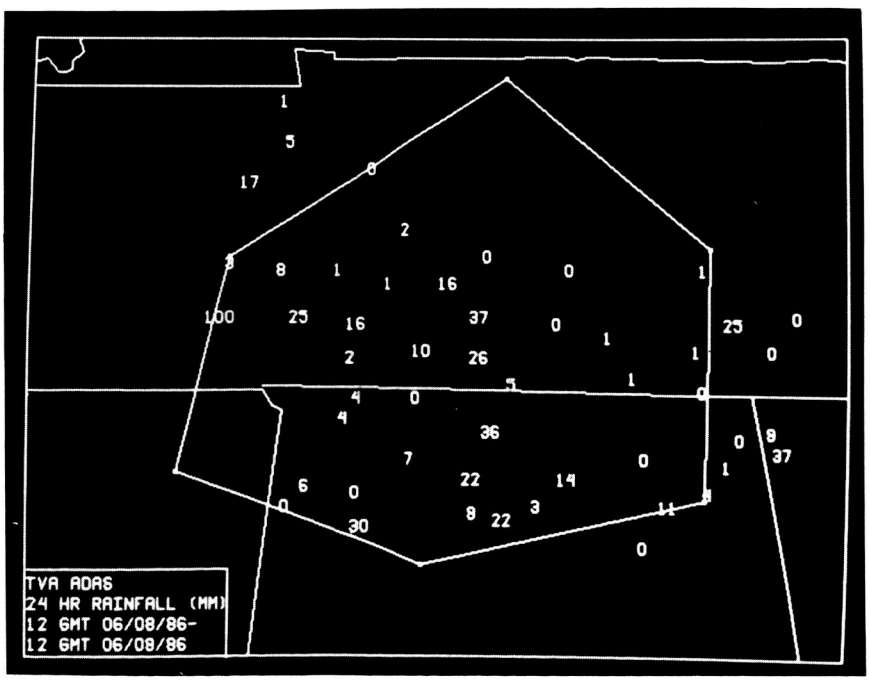


Fig. 3.2-7e. Twenty-four hour TVA ADAS rainfall totals (mm) for 8-9 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

9 June 1986

Synoptic Conditions

A stationary front was located over the extreme northeastern corner of the SPACE mesonet, showing no detectable movement during the day. A large 1025 mb surface anticyclone trailing an upper level short wave trough moved over the Great Lakes region, but was too far north to provide any significant southward frontal push. A deep trough continued to build over the western U.S., while a more broad upper level ridge strengthened over the Southeast. Over the SPACE mesonet, upper level flow was generally southwesterly at 5-10 m s^{-1}. Precipitable water values remained uniformly high near 50 mm over the SPACE mesonet. Afternoon surface temperature and dewpoint values were ~30 and 22 °C, and surface flow was generally 2-4 m s^{-1} from the south.

Cloud/Precipitation Overview

A general early morning overcast dissipated by the middle morning hours thus allowing a quicker start to surface heating. Scattered pre-dawn thunderstorms were observed around 0930 GMT. Weak to moderately intense deep convection reformed a north-south line of echoes by late morning. This line moved eastward out of multiple Doppler coverage by early afternoon, and echoes failed to redevelop over the MIST/FLOWS network thereafter. The line continued to move east during the afternoon hours. From 1700 to 1800 GMT, a large number of small and weak echoes were located along an outflow boundary near and to the east of the Doppler network. Later on, several other short-lived, weak echoes were observed 15-25 km west and southwest of CP-4. Another cluster of 40-50 dBZ echoes was observed 80-100 km west of CP-4 from 2100 to 2300, but these dissipated before moving into the MIST/FLOWS network. The most widespread deep convection (1800-0000 GMT) was located over central Tennessee 100 km north of the MIST/FLOWS network. Rainfall amounts were heavy (>40 mm) over portions of the northeastern SPACE mesonet.

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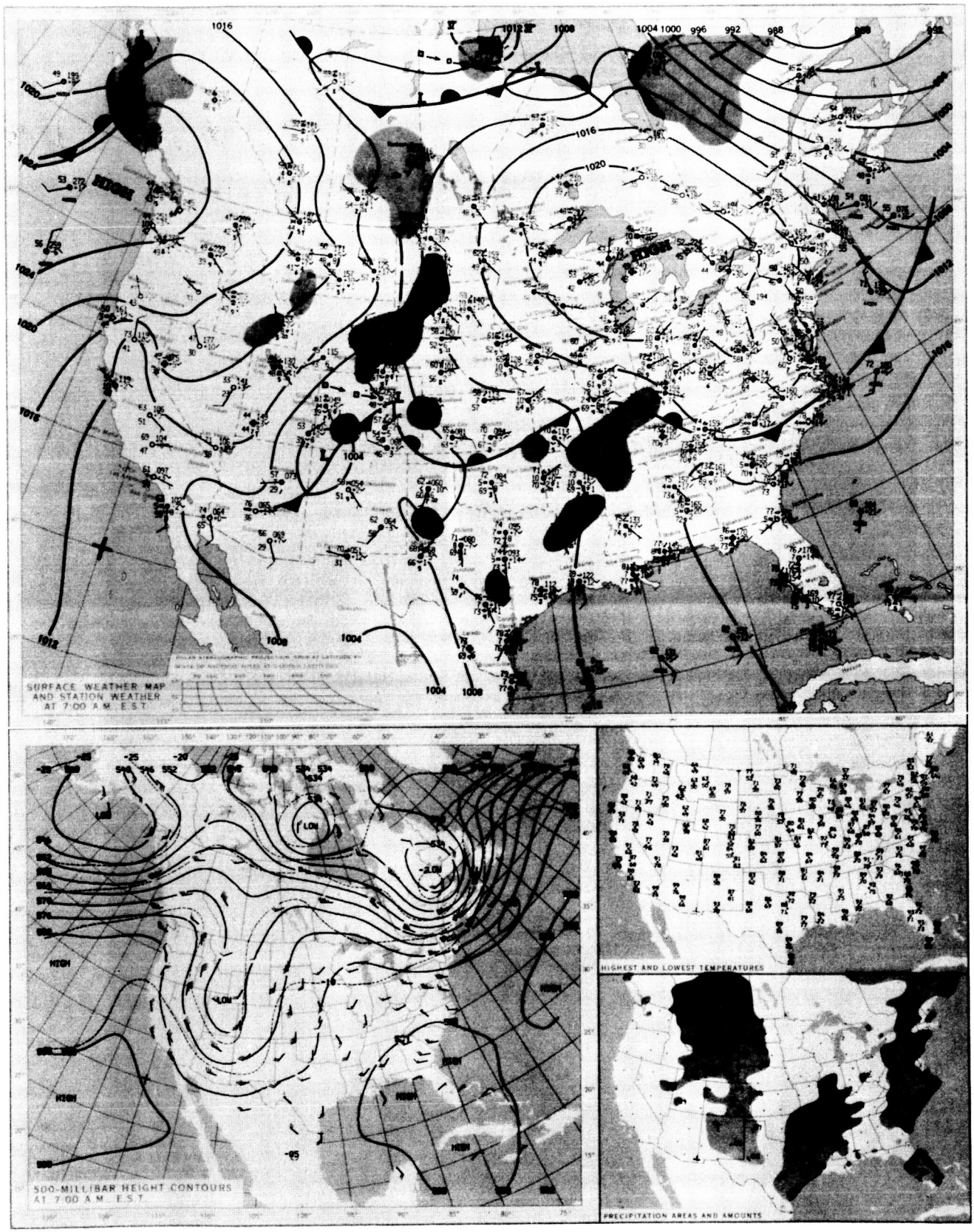


Fig. 3.2-8a. Synoptic weather conditions for 9 June 1986 1200 GMT

OPERATIONAL SUMMARY

9 June 1986

Rawinsonde Operations

A 9 station Meso-beta rawinsonde operation was conducted at 3-h intervals from 1500 to 0300 GMT. The surrounding NWS rawinsonde stations also launched 3-h soundings from 1200 to 0300 GMT.

Radar Operations

CP-3 and CP-4 performed some dual Doppler scans on precipitating convection located to the southeast of the MIST/FLOWS network for about 30-min around 1730 GMT. This was followed by miscellaneous scans from 1815 to 1900 GMT. At 1900 GMT, dual Doppler scans on the clear air PBL and an outflow boundary created by previous convection were implemented. CP-4 also provided general surveillance scans throughout, as well as occasional VAD scans of the clear air. CP-2 acquired some test data during two prolonged periods. BNA RADAP was down all day. FL-2 captured the latter stages of the early morning activity, as well as the afternoon convection.

Satellite Operations

GOES VAS products were not available. RISOP was started at 1830 GMT.

Aircraft Operations

No operations.

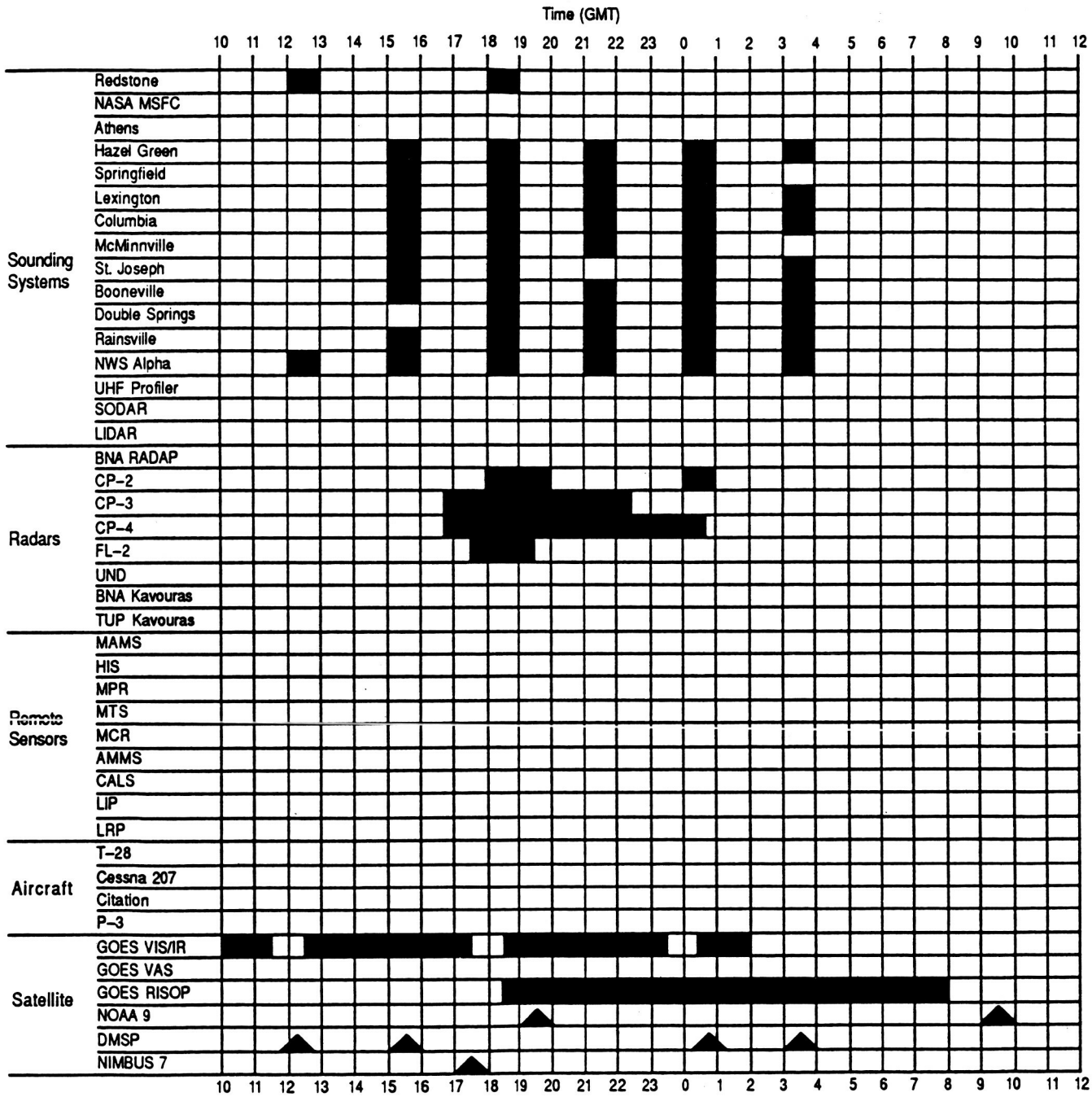
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5-550-7-8(08)

Day: MONDAY
Date: 6/9/86
Julian Day: 160-161

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 5, & 7
	TVA ADAS	MISSING STATIONS 23, 25, 32, 45, & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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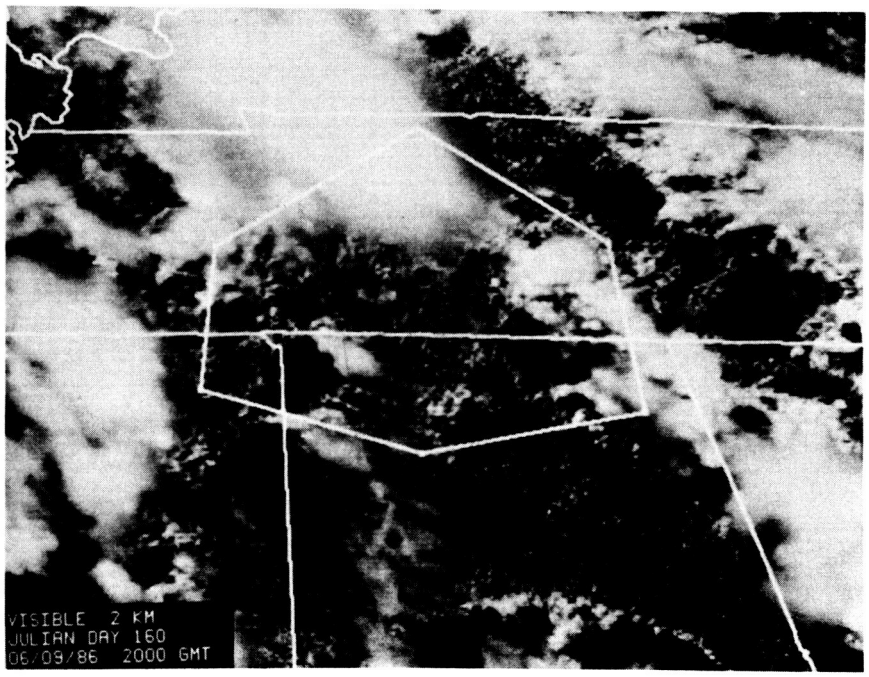


Fig. 3.2-8b. Visible 2 km GOES Central satellite image for 9 June 1986 2000 GMT

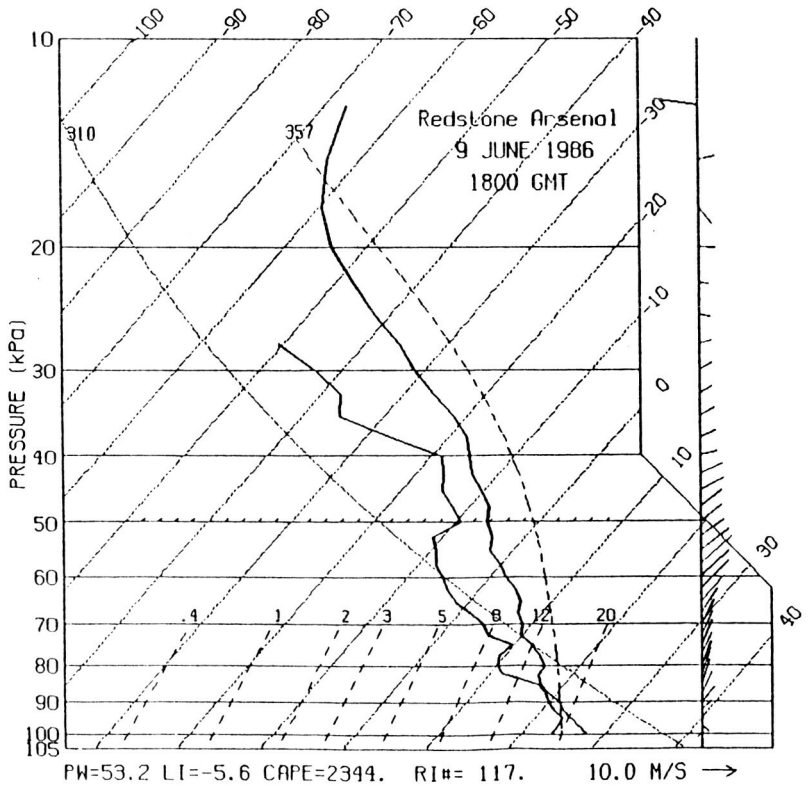


Fig. 3.2-8c. Redstone Arsenal, AL, rawinsonde sounding for 9 June 1986 1800 GMT

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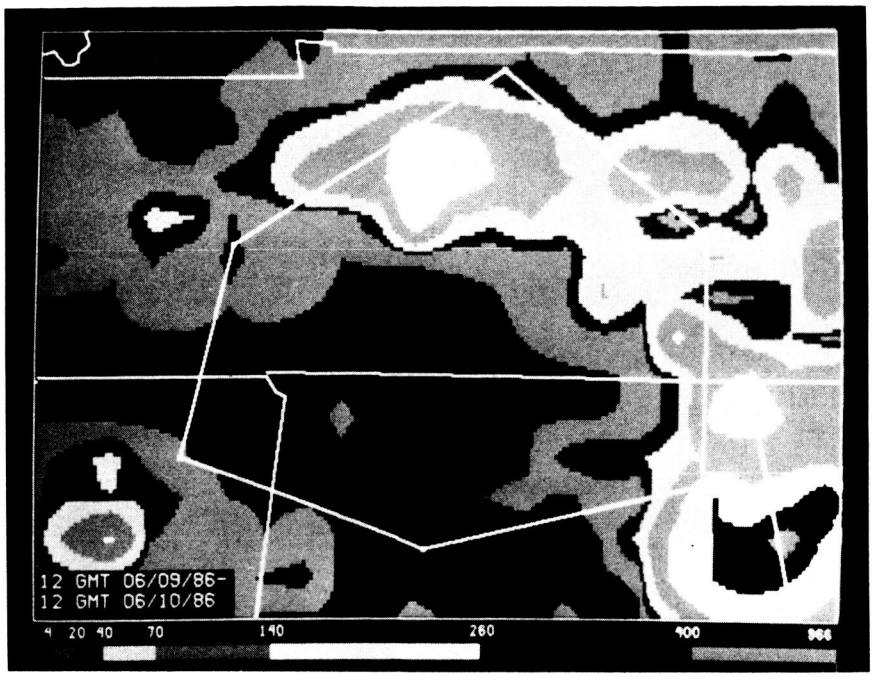


Fig. 3.2-8d. Twenty-four hour lightning strike density plot for 9-10 June 1986

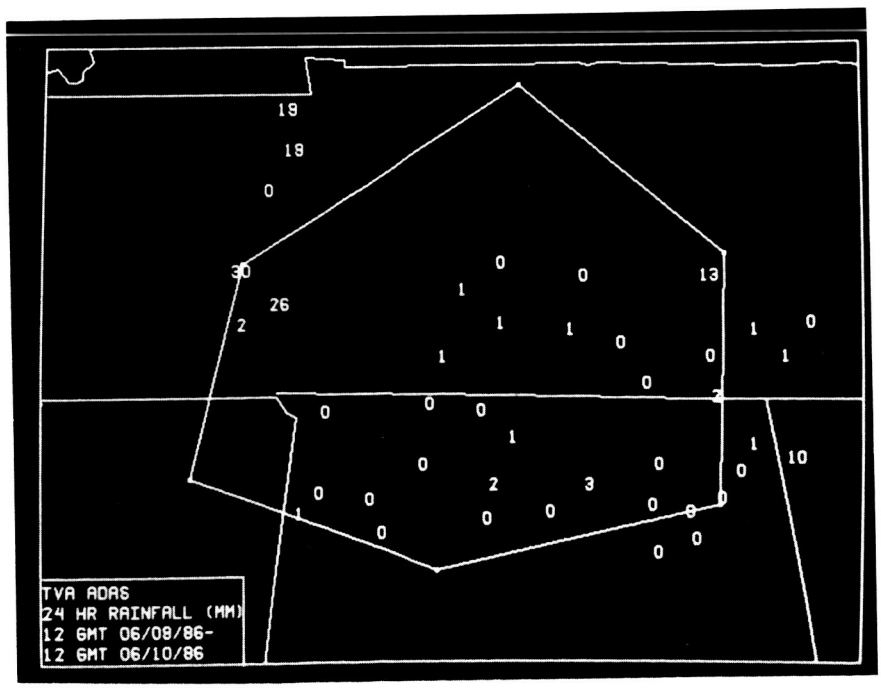


Fig. 3.2-8e. Twenty-four hour TVA ADAS rainfall totals (mm) for 9-10 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

10 June 1986

Synoptic Conditions

The upper level trough located over Nevada yesterday continued its eastward movement, cutting off and then accelerating eastward from 1200 to 0000 GMT today. At least one minor short wave trough located to the east of the major trough was apparent in the 1200 GMT NMC analysis. Upper level southwesterly flow over the SPACE region accelerated over yesterday's values in response to the approaching upper level trough. Precipitable water values near 50 mm remained very high. At the surface, the stationary front visible yesterday had rotated 90° and was located just beyond the eastern border of the SPACE mesonet. Thermodynamic properties at low levels over the SPACE mesonet remained relatively uniform. Afternoon temperature and dewpoint values were 28-30 and 21-23 °C in the presence of southwesterly surface flow.

Cloud/Precipitation Overview

The morning began with very light showers falling from an overcast of middle to upper level clouds. This overcast thinned and broke up by late morning, thus allowing for surface heating and convective cloud development by 1800 GMT. By 2000 GMT, cumulus congestus were common. A north-south line of deep convection formed over the western SPACE mesonet around 1900 GMT and moved eastward over the MIST/FLOWS network while weakening to a sustained rainband, 20-30 km wide and more than 150 km long. Lightning counts were relatively low from this line. Rainfall amounts were generally light and scattered over the southern beta region.

Notes:

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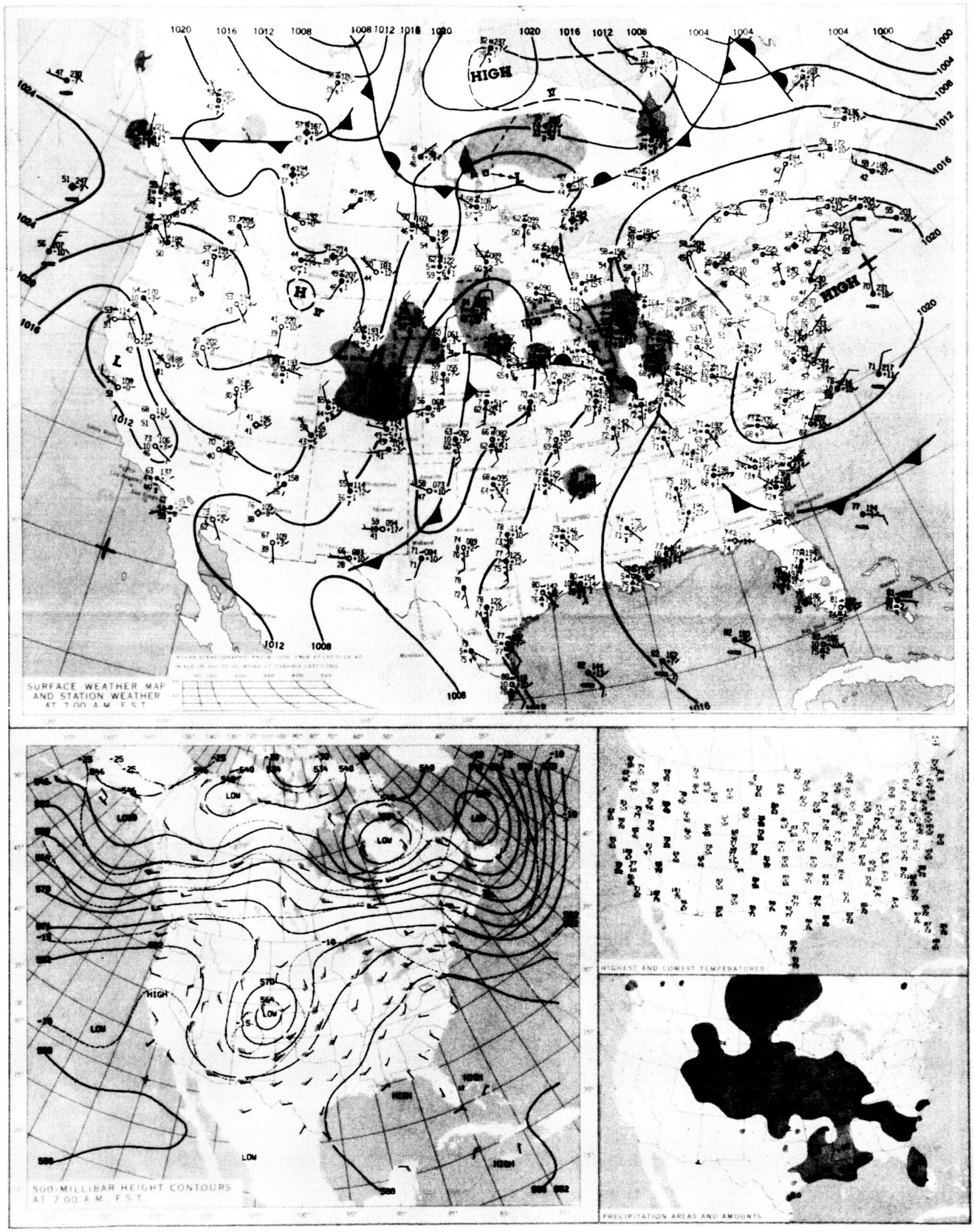


Fig. 3.2-9a. Synoptic weather conditions for 10 June 1986 1200 GMT

OPERATIONAL SUMMARY

10 June 1986

Rawinsonde Operations

Soundings were successfully released from 7 Meso-beta stations at 1500 GMT only. The normal RSA soundings were taken at 1200 and 1800 GMT, in addition to a post-storm special sounding at 0000 GMT.

Radar Operations

CP-2 was up and fully operational for the first time during the experiment. Dual Doppler scans were conducted on isolated convection from 1735 to 1840 GMT in the western sector, and from 1854 to 1930 GMT in the western sector. Miscellaneous surveillance, VAD, PPI and RHI scans (including dual Doppler) were conducted from 2030 to 2200 GMT on a precipitation band as it moved through the MIST/FLOWS network. The BNA RADAP was again down all day. FL-2 personnel noted two microbursts and two associated gust fronts south and west of the MIST/FLOWS mesonet during 1830 - 2000 GMT. Echo tops and intensities attained values of 14 km and >55 dBZ, respectively. As the stratiform line moved over the MIST/FLOWS network, NEXRAD long-range scans were implemented.

Satellite Operations

VAS products were again unavailable due to problems at Wallops Island, Va. RISOP was in effect from 1830 to 0800 GMT, and should cover the evolution of deep convection in the COHMEX region.

Aircraft Operations

No operations.

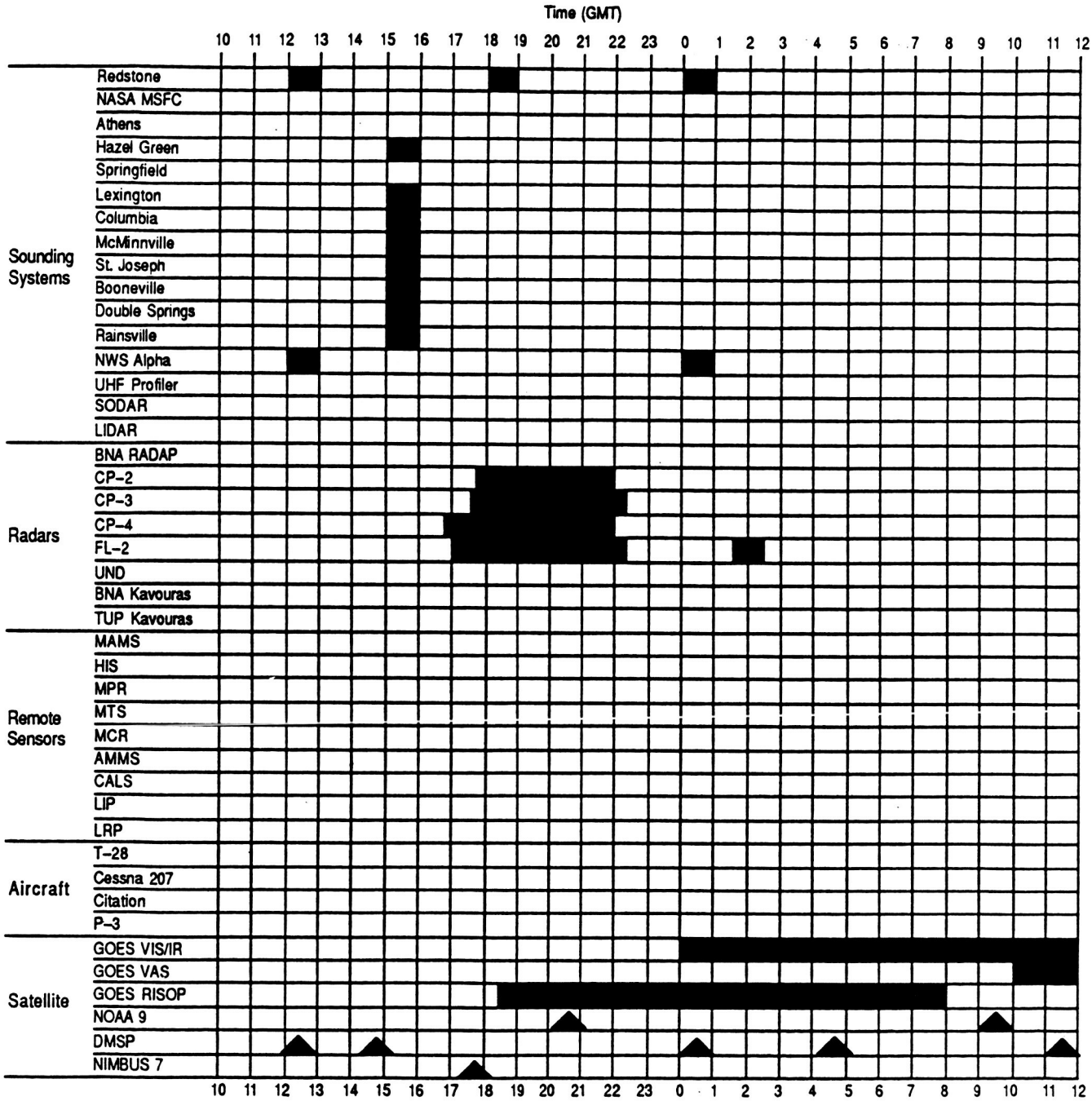
Notes:

5-550-7-8(09)

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Day: TUESDAY
Date: 6/10/86
Julian Day: 161-162

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 5, & 7
	TVA ADAS	MISSING STATION 45
	LLP	OPERATIONAL
	Mobile Lab	OPERATIONAL 1904–2048 GMT

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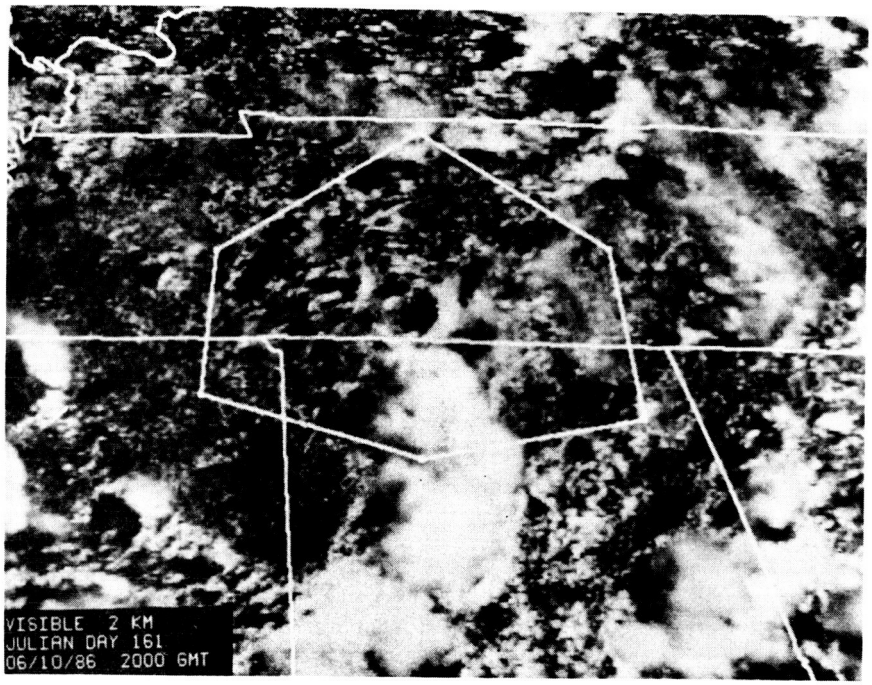


Fig. 3.2-9b. Visible 2 km GOES Central satellite image for 10 June 1986 2000 GMT

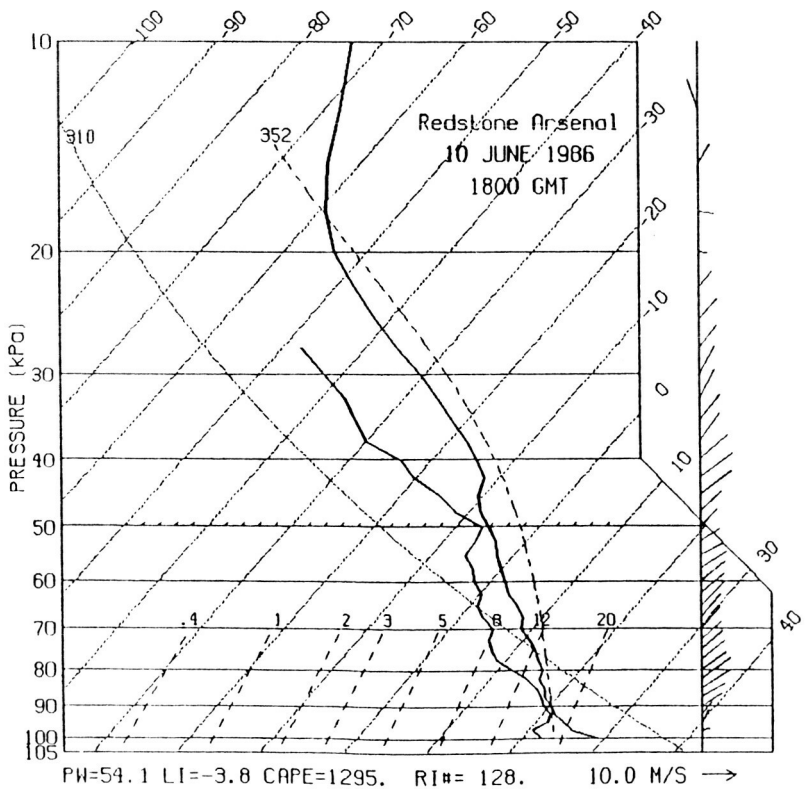


Fig. 3.2-9c. Redstone Arsenal, AL, rawinsonde sounding for 10 June 1986 1800 GMT

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Fig. 3.2-9d. Twenty-four hour lightning strike density plot for 10-11 June 1986

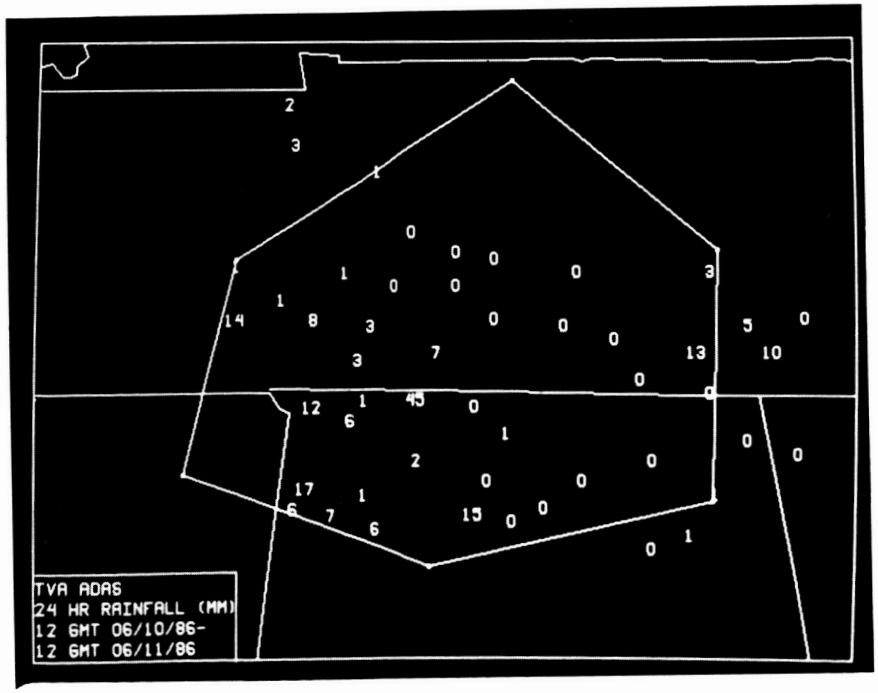


Fig. 3.2-9e. Twenty-four hour TVA ADAS rainfall totals (mm) for 10-11 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

11 June 1986

Synoptic Conditions

Abundant moisture at lower to middle levels remained over the SPACE region. Morning rain showers were present over central Tennessee, and along the Gulf Coast. The morning visible satellite loop indicated a generalized stratus overcast over northern Alabama. The eastward advancing western edge of this stratus was situated near the Alabama-Mississippi border. Vertical shear increased to moderate levels on the 1200 GMT RSA sounding in response to increased southwesterly flow at middle levels. Both wind shear and static instability were expected to increase in response to the forecast movement of a short wave trough into the network by evening. At the surface, both a cold front and a weak surface trough were connected to a relatively deep cyclone (central pressure of 998 mb) located over southern Wisconsin at 2100 GMT. The trough moved through the beta network from 2100 to 0200 GMT, while the cold front moved over the network from 1000 to 1600 GMT 12 June. At 500 mb a subtle short wave was associated with the surface trough and was located to the east of the major long wave trough over Oklahoma at 0000 GMT 12 June. Afternoon surface temperature and dewpoint values over the SPACE mesonet were 28-30 and 21-23 °C, respectively.

Cloud/Precipitation Overview

The morning stratus overcast over the SPACE region disappeared by late morning. An organized MCS developed by midmorning over north-central Mississippi and moved very rapidly (60 km h^{-1}) eastward, arriving over the MIST/FLOWS region by 2100 GMT. As viewed from CP-4 radar at 1900 GMT, this system consisted of a north-south convective line flanked to the rear by a stratiform precipitation region. As the line moved into dual Doppler coverage, it quickly dissipated, leaving behind a lingering stratiform precipitation band. Almost concurrently, a background field of cumulus congestus disappeared, suggesting a quick onset of subsidence over a large region.

After a lull in convective activity from 2100-2300 GMT, explosive growth took place over the western and central SPACE mesonet beginning near 2300 GMT. These thunderstorms quickly consolidated to form an intense squall line. A weak tornado touched down at 2320 GMT 6 miles northeast of Florence and moved northeast through the town of Killen, Al. Most of the property damage occurred in Killen where large trees fell on roofs of homes. This system propagated east-south eastward and moved over the MIST/FLOWS network from 0030 to 0200 GMT. The squall line produced strong winds, locally heavy rain, and exhibited a quasi-cellular 60 km wide stratiform precipitation region located along its rear flank. Measured rainfall to 41 mm fell over the MIST/FLOWS network and over the southern SPACE mesonet.

Notes:

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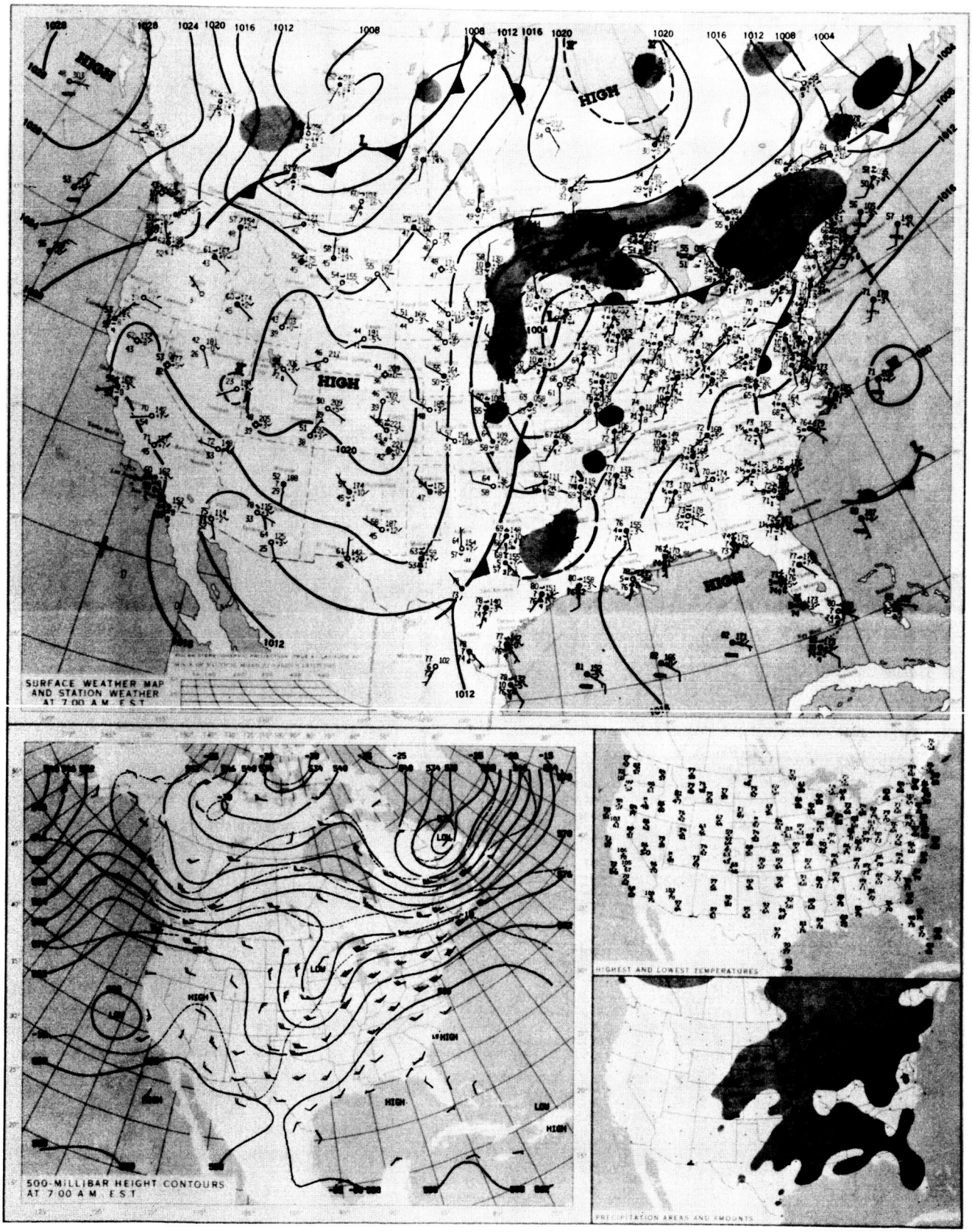


Fig. 3.2-10a. Synoptic weather conditions for 11 June 1986 1200 GMT

OPERATIONAL SUMMARY

11 June 1986

Rawinsonde Operations

Serial soundings were made at 1500, 1800, 2100, 0000 and 0300 GMT within the southern most beta triangle (St. Joseph, Redstone Arsenal, and Double Springs). These soundings should portray environmental characteristics of the dissipating convection near 1900 GMT and the developing squall line near 2200 GMT. The normal 1200 GMT rawinsonde sounding from RSA is also available.

Radar Operations

Data from the first convective line consisted of surveillance scans until about 1915 GMT, followed by full volume sector scans from 1915 to 2000 GMT. Dual Doppler data from CP-2 and CP-3 were taken as the weakening line entered the MIST/FLOWS network. As the line passed over the MIST/FLOWS network around 2030 GMT, VAD scans were conducted on the decaying rainband.

Data from the subsequent squall line were collected by only CP-2 and FL-2 . These data should cover much of the evolution of this line in a single Doppler mode. CP-2 conducted miscellaneous RHI and PPI scans in addition to occasional VAD scans at 5-6° elevations. No coordinated scans were conducted between FL-2 and CP-2. FL-2 personnel noted very strong outflow winds, strongly diverging tops, and reflectivity factor in excess of 60 dBZ within convective elements of the line.

Satellite Operations

Potentially valuable VAS data were collected until 1600 GMT, after which RISOP was started. The morning VAS data may portray horizontal differences in mesoscale thermodynamic structure that may help explain the sequence of observed events. The RISOP high temporal resolution data may be valuable for analyses of the two contrasting MCSs that were observed within the SPACE network.

Aircraft Operations

No operations.

Notes:

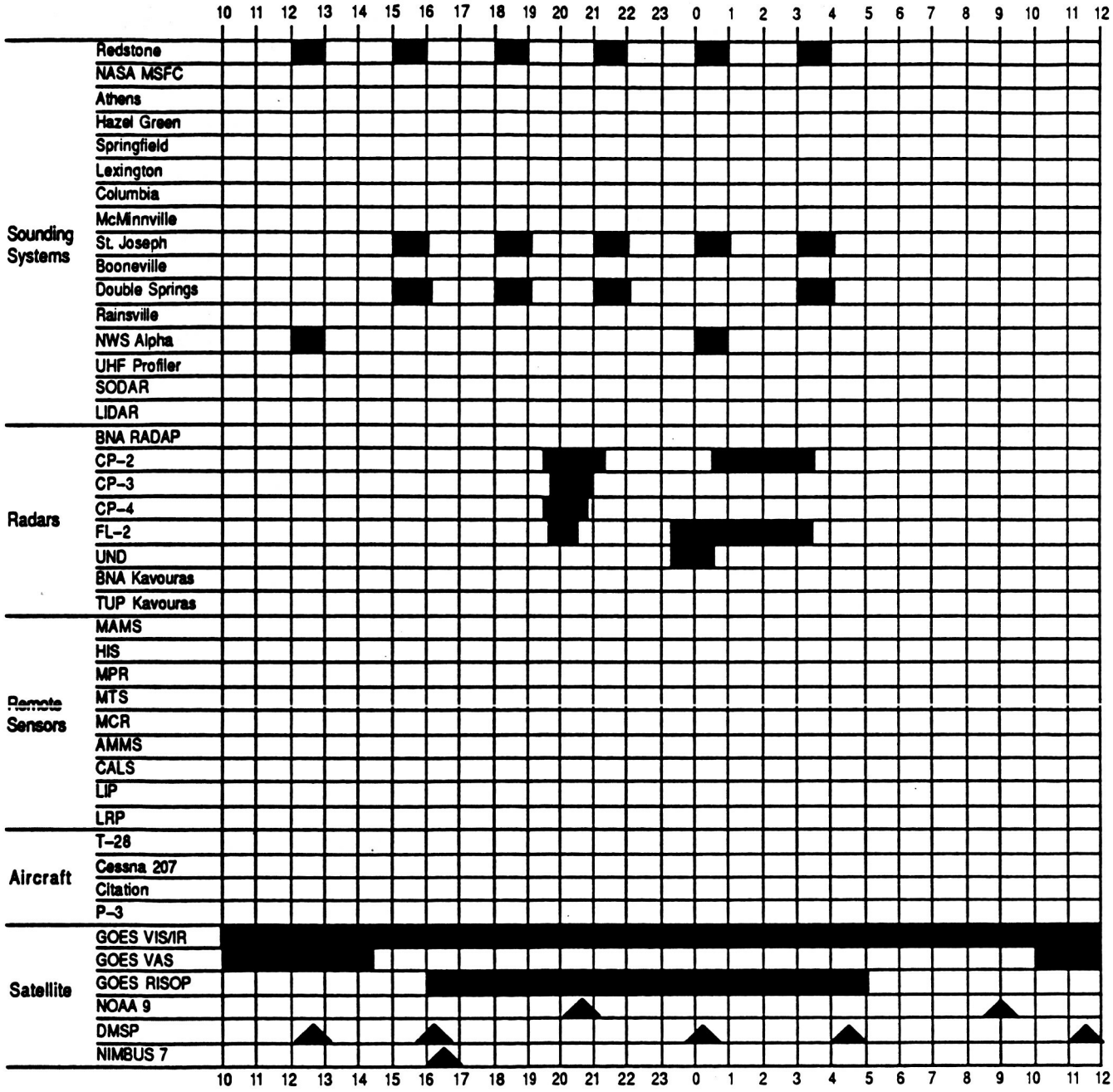
5-550-7-8(10)

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Day: WEDNESDAY
Date: 6/11/86
Julian Day: 162–163

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 2, 5, & 7
	TVA ADAS	MISSING STATIONS 28 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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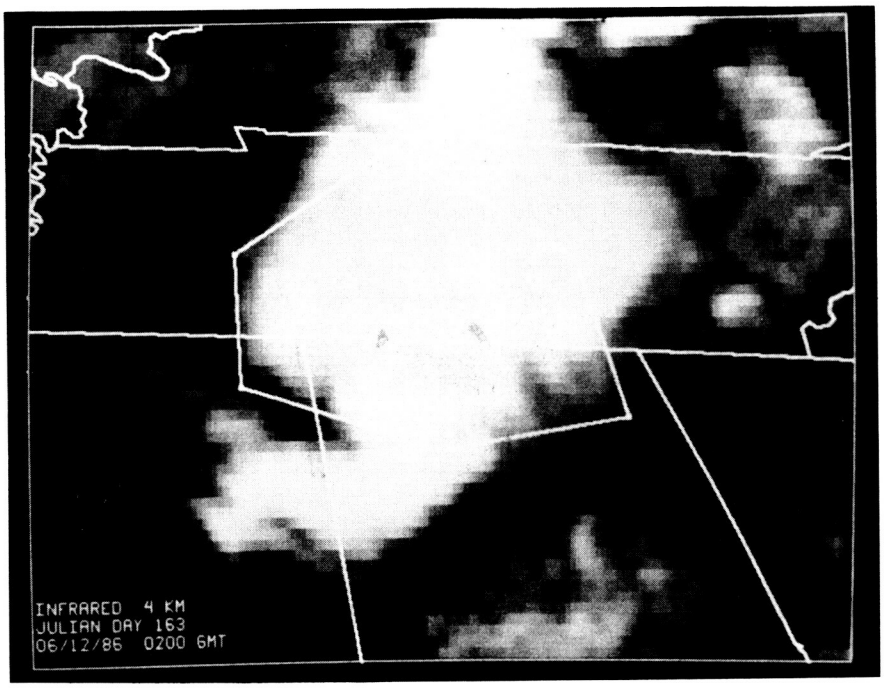


Fig. 3.2-10b. Infrared 4 km GOES Central satellite image for 11 June 1986 0200 GMT

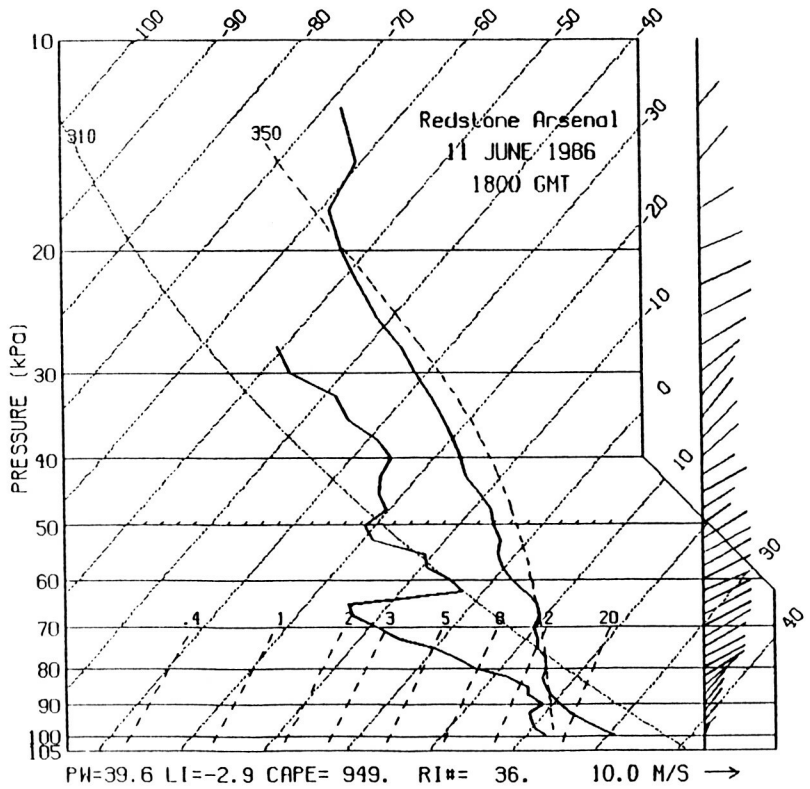


Fig. 3.2-10c. Redstone Arsenal, AL, rawinsonde sounding for 11 June 1986 1800 GMT

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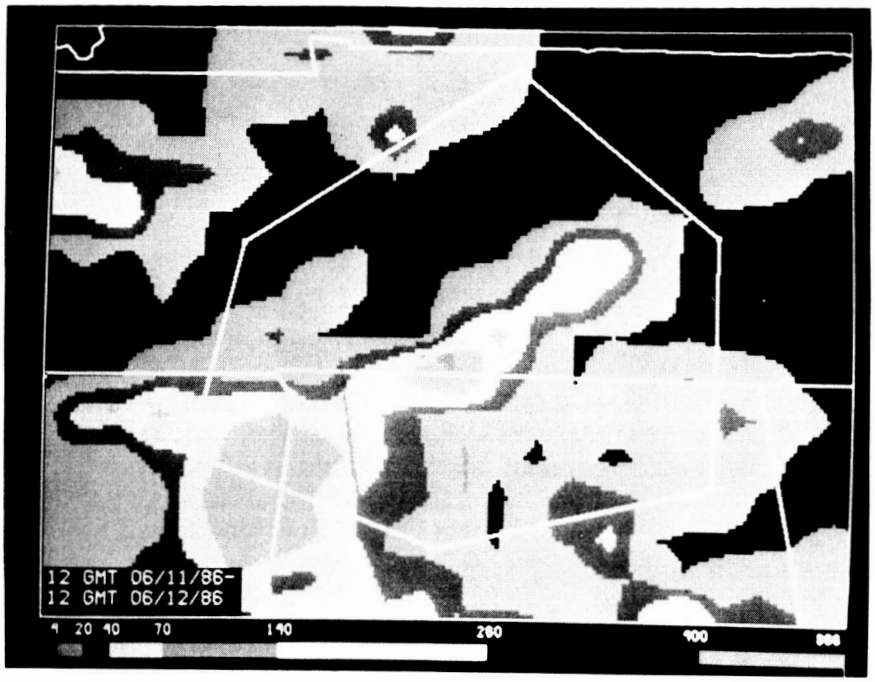


Fig. 3.2-10d. Twenty-four hour lightning strike density plot for 11-12 June 1986

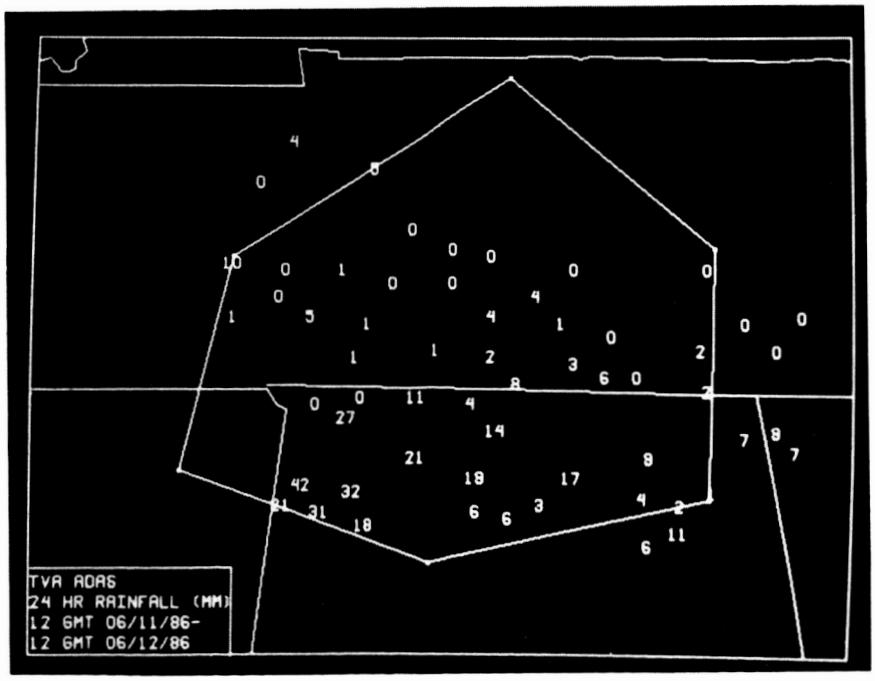


Fig. 3.2-10e. Twenty-four hour TVA ADAS rainfall totals (mm) for 11-12 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

12 June 1986

Synoptic Conditions

The cold front that was approaching the network yesterday moved through the center of the SPACE mesonet around 1200 GMT. At this time, the front extended from northern Alabama to central Michigan. By 2100 GMT the front had translated through the eastern edge of the mesonet. Wind shifts across the front at low levels were not large, but thermodynamic difference did exist over a broad frontal zone. Winds increased from the west to 15 m s^{-1} at lower to middle levels. Increased stability and drying were apparent on the 1800 GMT RSA sounding. The short wave trough that appeared to help trigger last night's squall line was located northeast of the beta network at 1200 GMT, while a secondary PVA maximum was located over Arkansas. By midafternoon, surface temperature and dewpoint values over the SPACE mesonet were 24-27 and 16-18 °C, respectively, and flow was westerly at ~ 5 m s^{-1}.

Cloud/Precipitation Overview

This was a quiet and stable post-frontal day over the SPACE network. A few cumulus congestus were observed just behind the front near 1200 GMT. A field of scattered cumulus mediocris persisted over the entire SPACE mesonet during the afternoon hours. Two small anvils were observed near the western horizon at sunset.

Notes:

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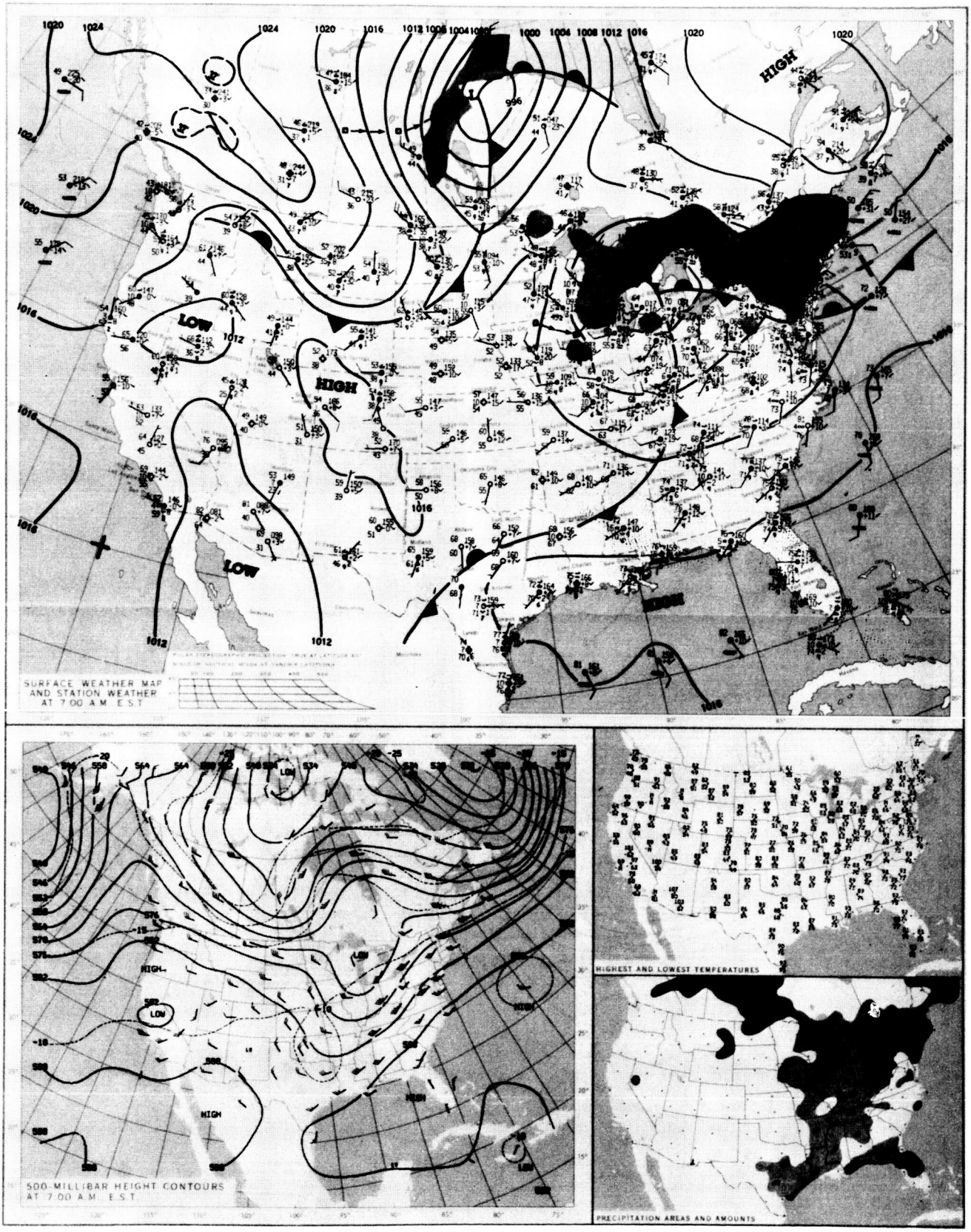


Fig. 3.2-11a. Synoptic weather conditions for 12 June 1986 1200 GMT

OPERATIONAL SUMMARY

12 June 1986

Rawinsonde Operations

A 3 station (single triangle) rawinsonde operation was conducted over the south-central beta network at 3-h intervals from 1200 to 1800 GMT. These soundings should provide a good sampling of the post-frontal air mass.

Radar Operations

No operations.

Satellite Operations

The only special operation was RISOP, which was started at 1600 GMT. The VAS data collection from 1000 to 1500 GMT will complement the rawinsonde data that was acquired during part of this period.

Aircraft Operations

No operations.

Notes:

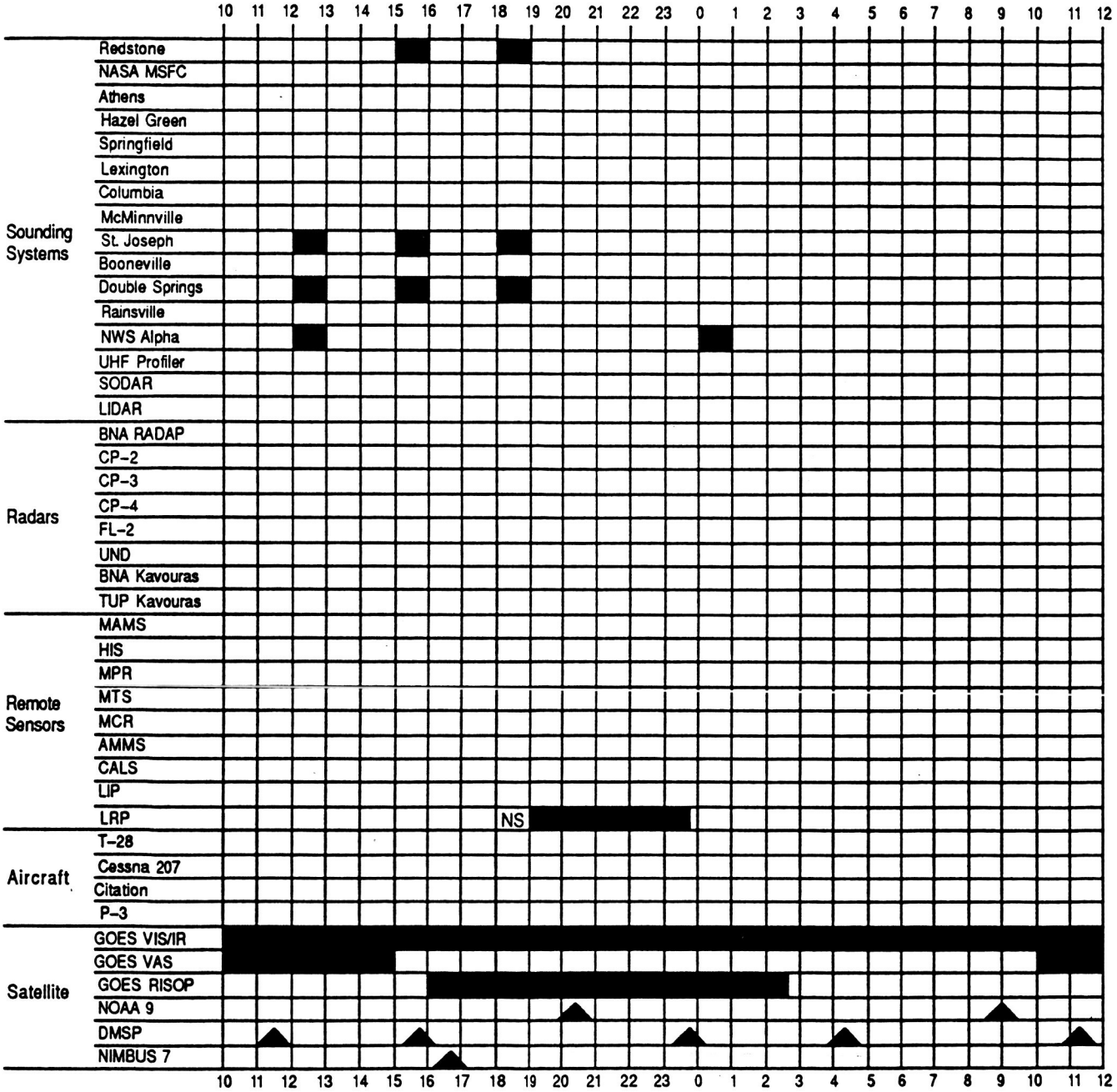
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5-550-7-8 (11)

Day: THURSDAY
Date: 6/12/86
Julian Day: 163–164

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 1, 2, 4, 5, & 7
	TVA ADAS	MISSING STATIONS 26, 28, 35, 40, 45, 56, & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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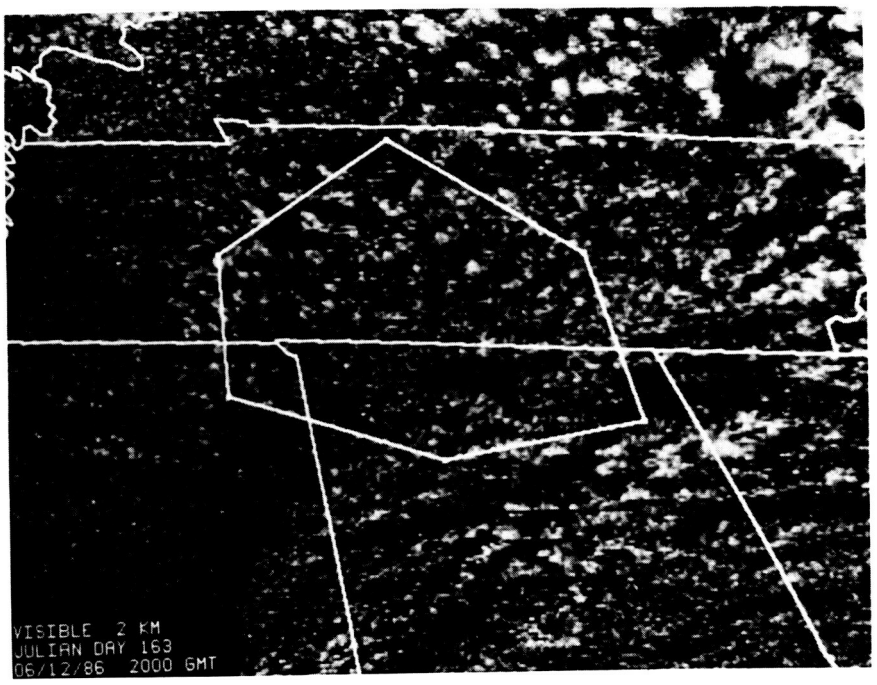


Fig. 3.2-11b. Visible 2 km GOES Central satellite image for 12 June 1986 2000 GMT

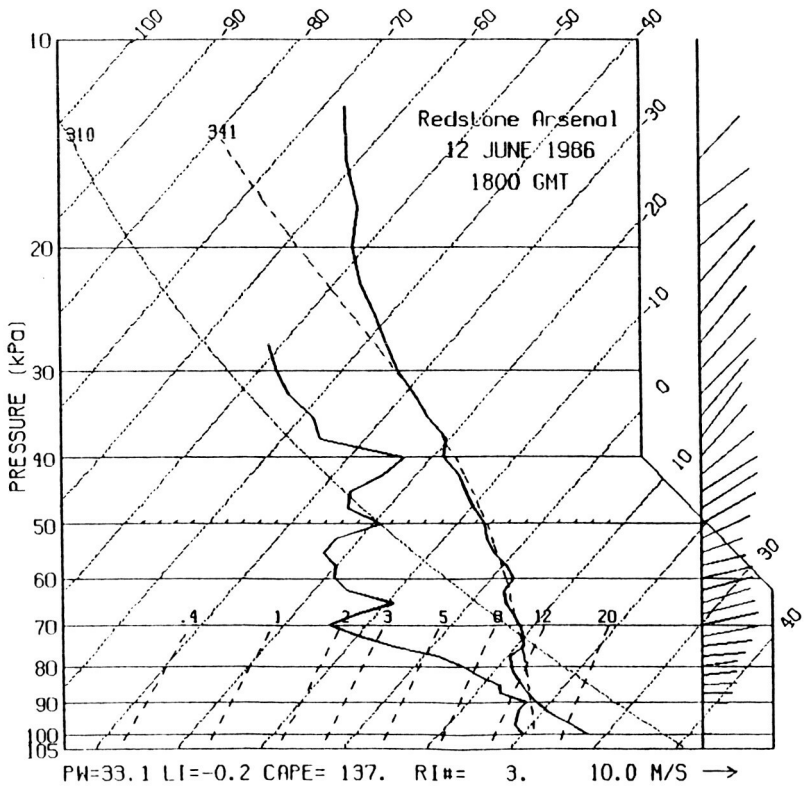


Fig. 3.2-11c. Redstone Arsenal, AL, rawinsonde sounding for 12 June 1986 1800 GMT

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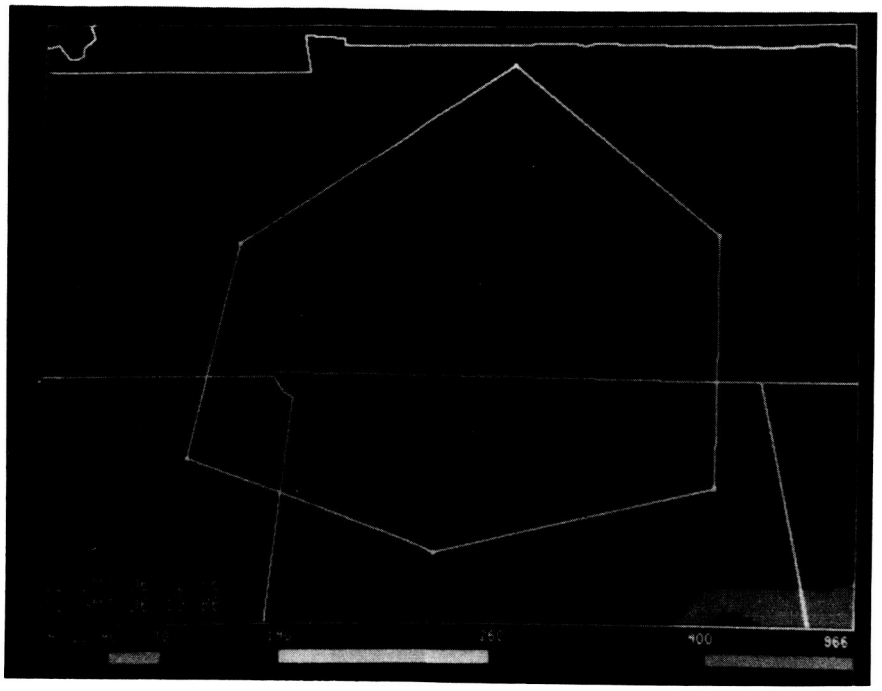


Fig. 3.2-11d. Twenty-four hour lightning strike density plot for 12-13 June 1986

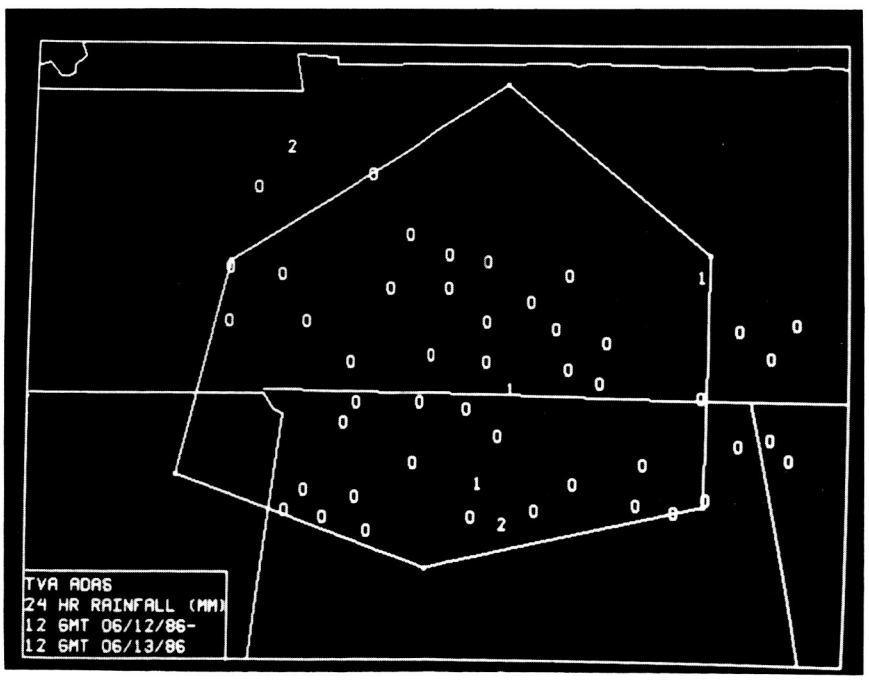


Fig. 3.2-11e. Twenty-four hour TVA ADAS rainfall totals (mm) for 12-13 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

13 June 1986

Synoptic Conditions

The cold front which moved through the SPACE network yesterday was located in much weakened form along the Gulf and Atlantic coasts. Negative vorticity advection to the rear of a short wave trough produced subsidence and associated clearing skies, greater stability and drier surface conditions. A prominent subsidence inversion, which would persist over the SPACE mesonet for the next 3 days, appears on the 1800 GMT RSA sounding. Surface temperatures and dewpoints over the network were 24-27 and 16-18 °C, respectively. Flow aloft was relatively weak and zonal.

Cloud/Precipitation Overview

No precipitating convective clouds developed over the SPACE region. However, some interesting cumulus cloud fields did appear in visible satellite images. Two features were:

1. enhanced bands of cumulus clouds separated by clear zones;
2. a zone of clearing which appeared over eastern Kentucky and then propagated radially outward from that point.

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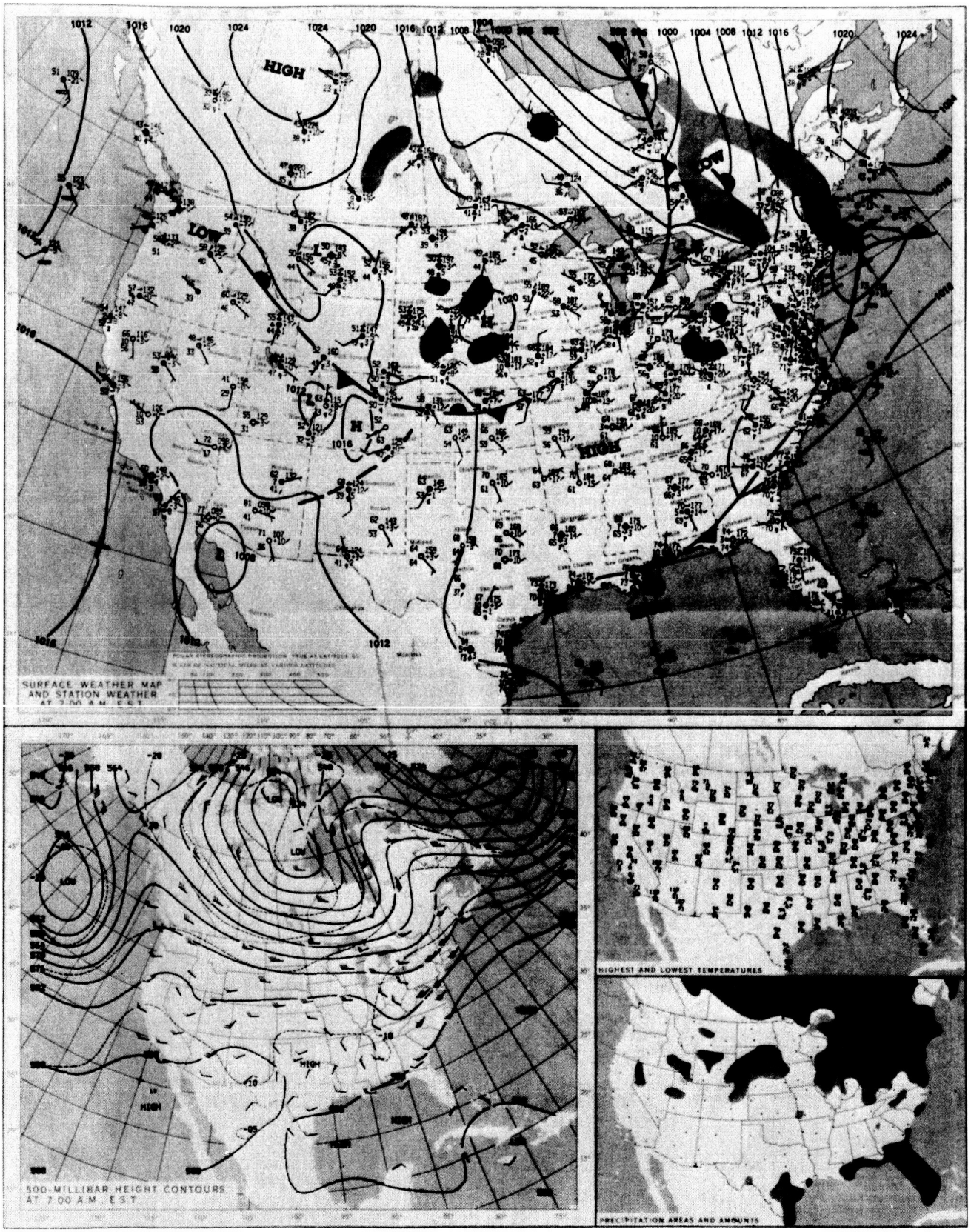


Fig. 3.2-12a. Synoptic weather conditions for 13 June 1986 1200 GMT

OPERATIONAL SUMMARY

13 June 1986

Rawinsonde Operations

The 1200 and 1800 GMT RSA soundings represent the only special releases.

Radar Operations

No operations.

Satellite Operations

GOES VAS data were collected during the morning hours from 1000 to 1730 GMT. These data may provide insight on what PBL inhomogeneities may have produced the subsequent convective cloud field patterns.

Aircraft Operations

No operations.

Notes:

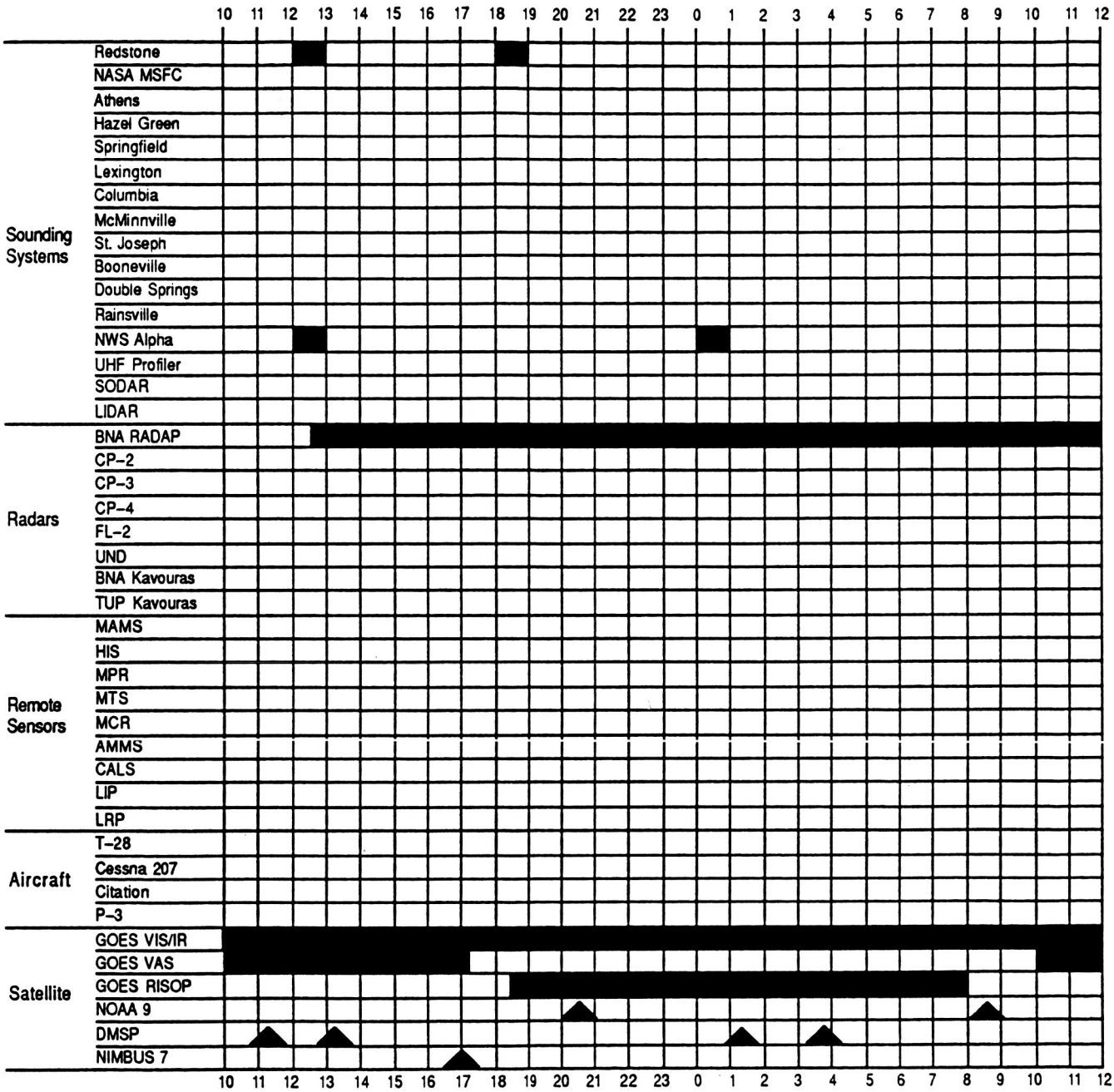
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5-550-7-8(12)

Day: FRIDAY
Date: 6/13/86
Julian Day: 164–165

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 1, 2, 4 & 5
	TVA ADAS	MISSING STATIONS 40, 45, 56 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

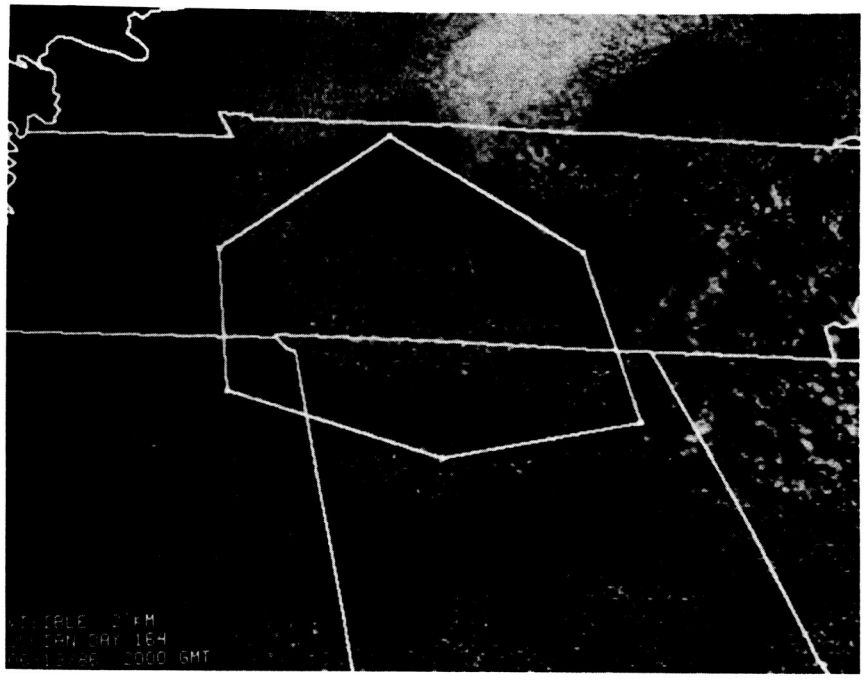


Fig. 3.2-12b. Visible 2 km GOES Central satellite image for 13 June 1986 2000 GMT

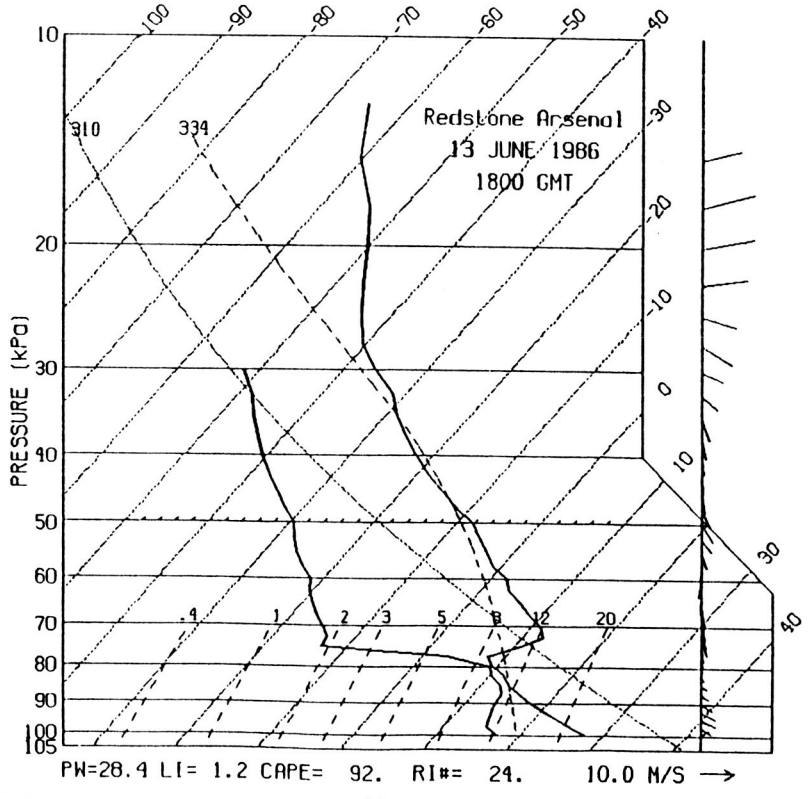


Fig. 3.2-12c. Redstone Arsenal, AL, rawinsonde sounding for 13 June 1986 1800 GMT

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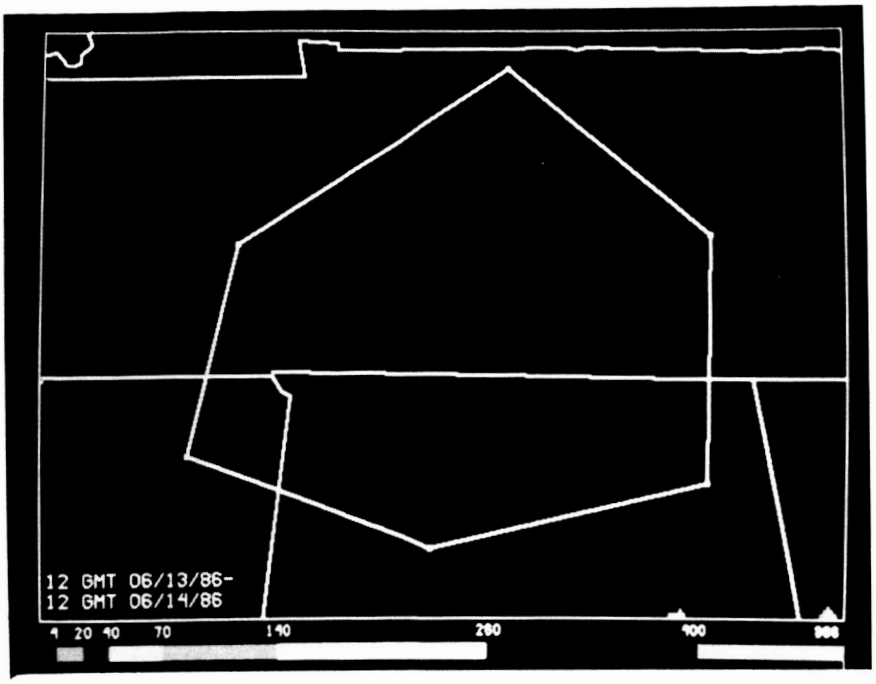


Fig. 3.2-12d. Twenty-four hour lightning strike density plot for 13-14 June 1986

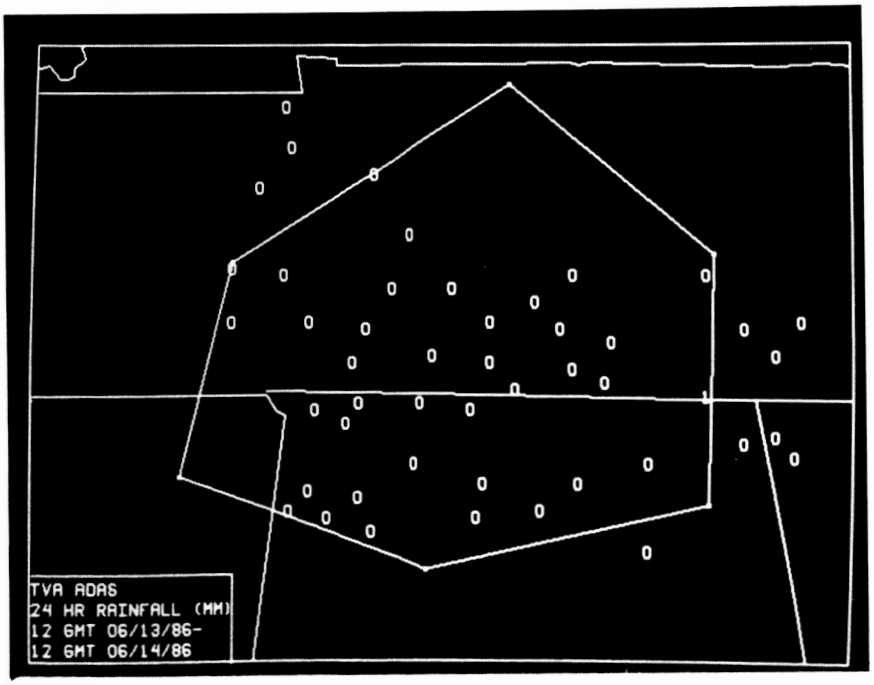


Fig. 3.2-12e. Twenty-four hour TVA ADAS rainfall totals (mm) for 13-14 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

14 June 1986

Synoptic Conditions

The prominent subsidence inversion in the 750-800 mb layer on yesterday's sounding was again present today. During the day, a warm core high pressure ridge was evident from the surface to above 500 mb. Winds aloft weakened to light and variable over the SPACE mesonet. A weak surface low pressure center located over eastern Kansas developed in response to an advancing upper level short wave trough. Associated with the surface low was an east-to-west oriented stationary front that extended eastward into the Northeast. Afternoon surface temperature and dewpoint values over the SPACE mesonet were 26-29 and 15-18 °C.

Cloud/Precipitation Overview

Generally stable conditions inhibited development of precipitating convection. Cumulus mediocris of up to 1 km depth were observed during the afternoon hours.

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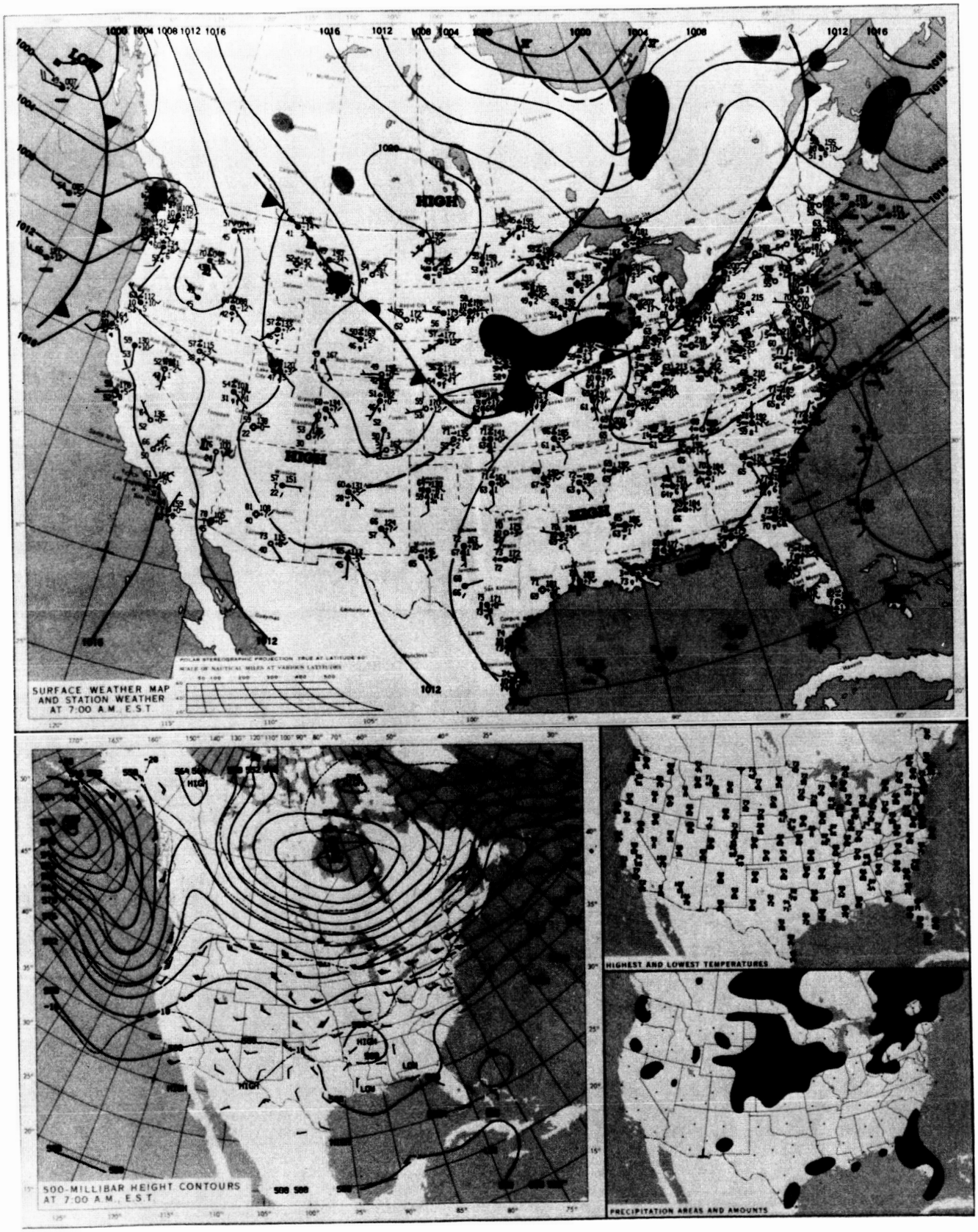


Fig. 3.2-13a. Synoptic weather conditions for 14 June 1986 1200 GMT

OPERATIONAL SUMMARY

14 June 1986

Rawinsonde Operations

The routine RSA soundings were released at 1200 and 1800 GMT.

Radar operations

No operations.

Satellite Operations

Generally clear skies over and around the SPACE mesonet should make this a good VAS day. VAS data were generated through 1900 GMT.

Aircraft Operations

No operations.

Notes:

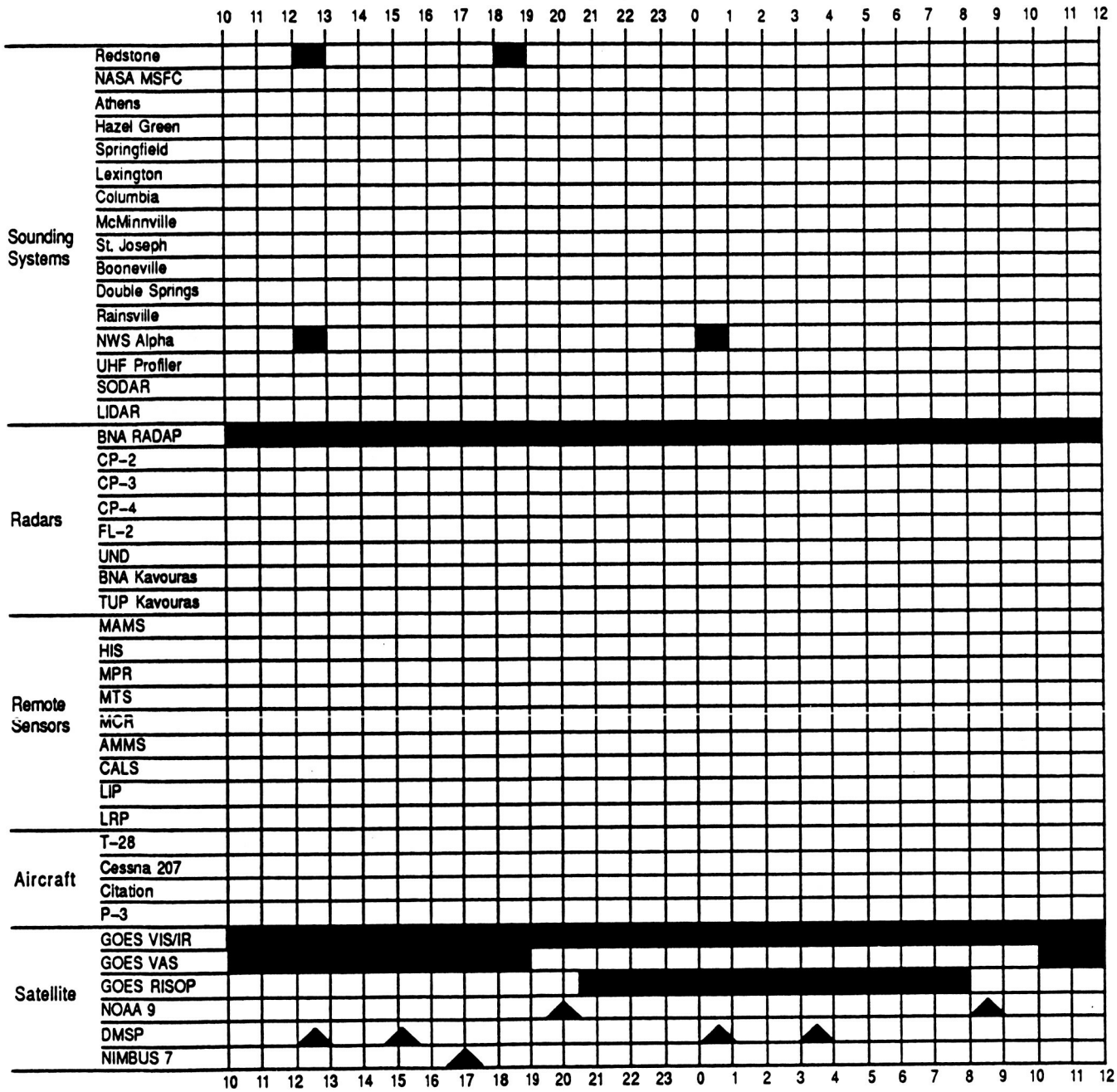
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5-550-7-8(13)

Day: SATURDAY
Date: 6/14/86
Julian Day: 165–166

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 1, 2, 4 & 5
	TVA ADAS	MISSING STATIONS 5, 26, 27, 37, 40, 45, 56 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

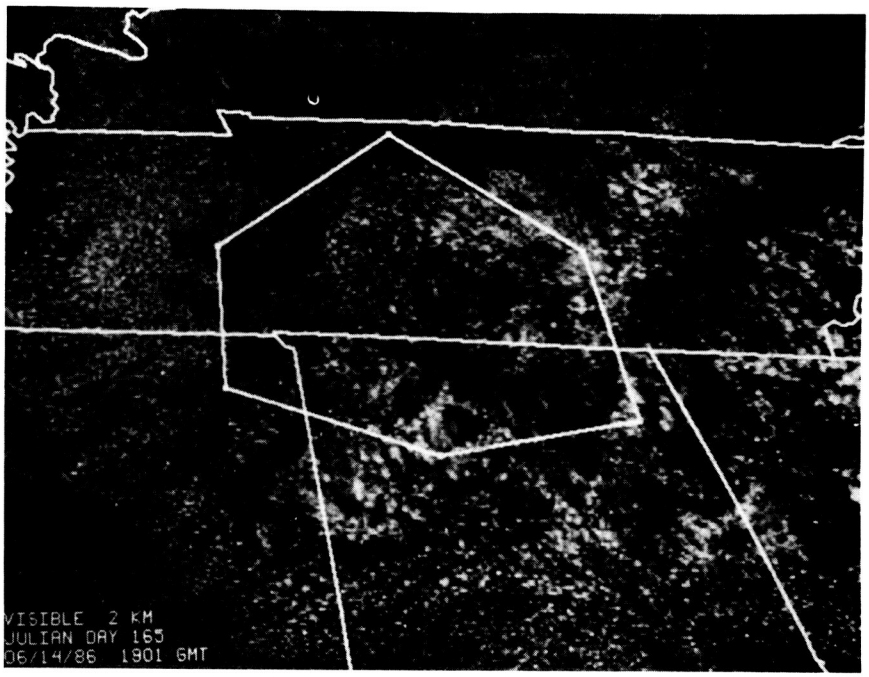


Fig. 3.2-13b. Visible 2 km GOES Central satellite image for 14 June 1986 1901 GMT

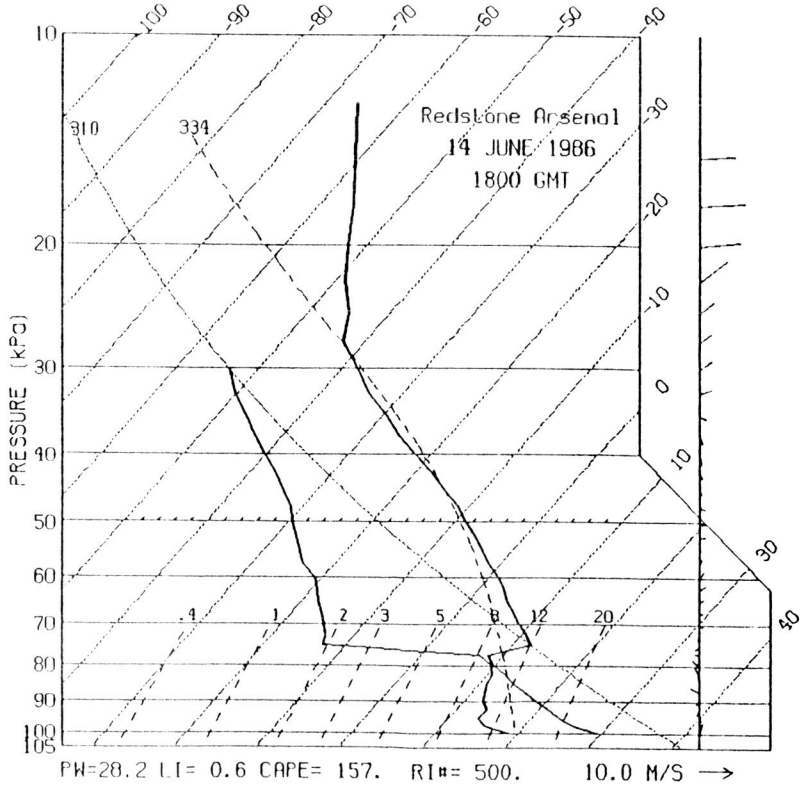


Fig. 3.2-13c. Redstone Arsenal, AL, rawinsonde sounding for 14 June 1986 1800 GMT

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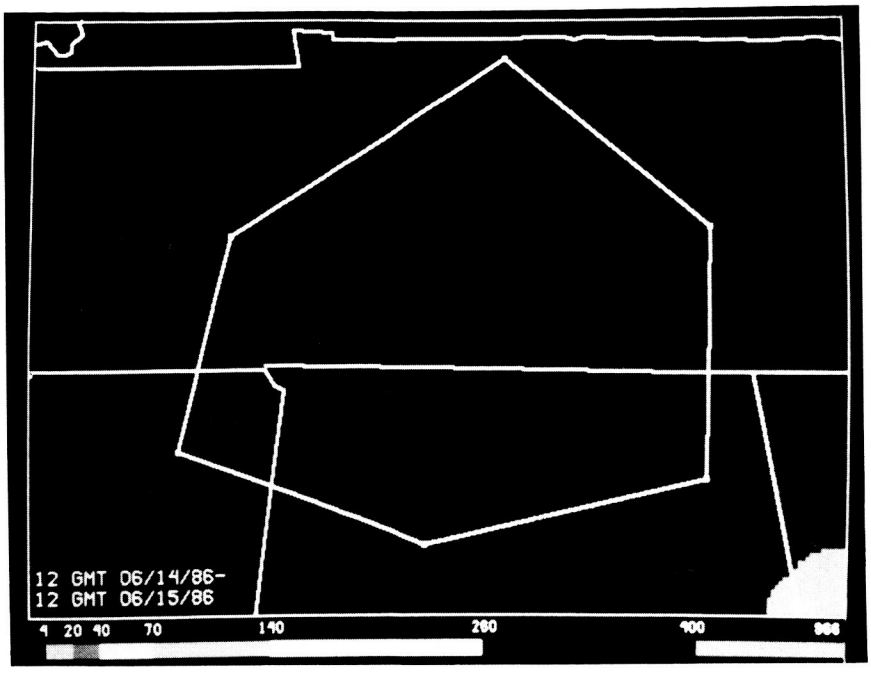


Fig. 3.2-13d. Twenty-four hour lightning strike density plot for 14-15 June 1986

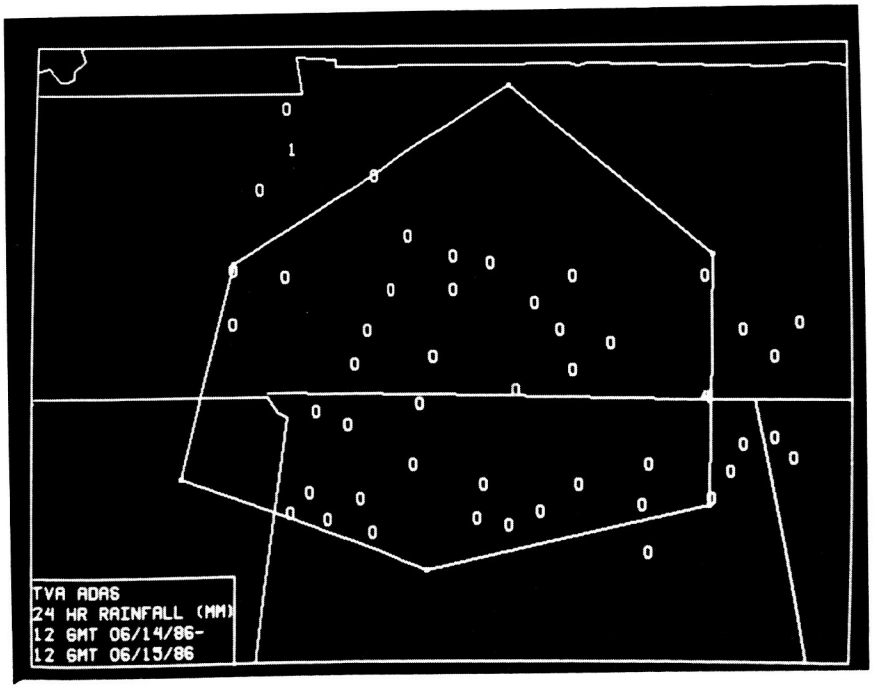


Fig. 3.2-13e. Twenty-four hour TVA ADAS rainfall totals (mm) for 14-15 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

15 June 1986

Synoptic Conditions

Generally stable and dry air remained over the SPACE region. The 1800 GMT RSA sounding once again exhibited a subsidence inversion near 800 mb. This inversion was weaker than on the previous two days. The morning 6.7 micrometer satellite water vapor image indicated a southwest to northeast orientation of a band of dry air centered approximately over the SPACE network. The strength of this inversion, combined with the lack of synoptic scale forcing, prevented the development of deep convection over the SPACE mesonet. On the synoptic scale, a diffuse stationary front remained well to north of the SPACE network. Upper level winds over the SPACE mesonet increased to ~5 m s^{-1} from the west. Minor short wave troughs were apparent at 1200 GMT over Arkansas and at 0000 GMT over eastern Oklahoma.

Cloud/Precipitation Overview

Generally clear skies during morning hours gave way to cumulus cloudiness by noon. Although some altocumulus stratiformis were observed midmorning, cumulus humilis and cumulus mediocris (~1 km deep) were dominant cloud forms from noon to midafternoon. Visible satellite imagery indicate an eastward propagation of an enhanced cumulus cloud field around 1800-1900 GMT. One may speculate that this occurred in response to gravity wave processes. No precipitation occurred over the SPACE mesonet.

Notes:

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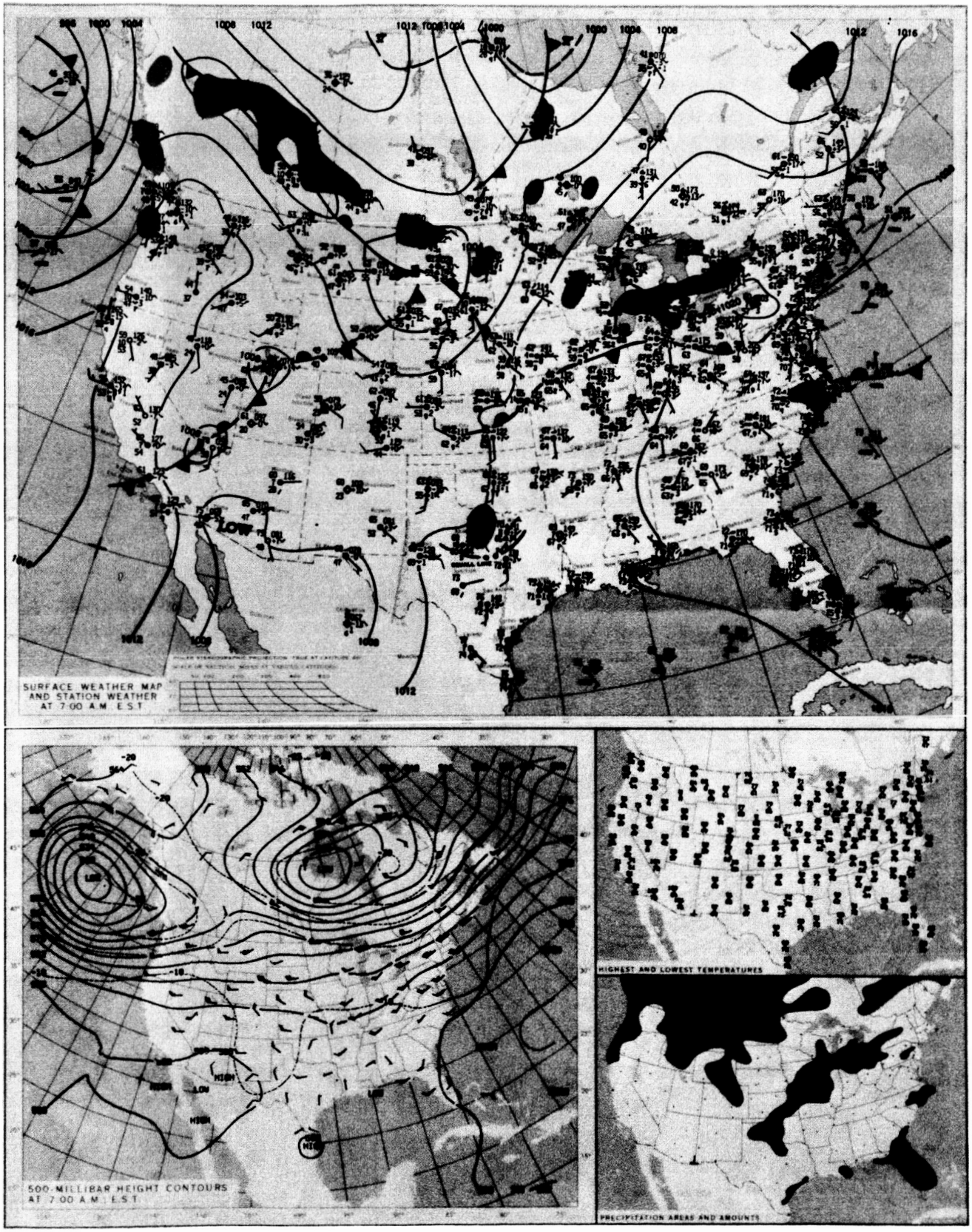


Fig. 3.2-14a. Synoptic weather conditions for 15 June 1986 1200 GMT

OPERATIONAL SUMMARY

15 June 1986

Rawinsonde Operations

A complete Meso-beta operation was conducted with 9 stations from 1500 to 2100 GMT. Data quality is considered fair overall due to the fact that only 16 of our 27 total soundings were successful.

Radar Operations

CP-2 recorded clear air PBL data nearly continuously from 1700 to 2030 GMT. Scans consisted of VAD scans, sectorized PPI scans, and RHIs. Data appear to be good, and clear air return from up to 120 km was noted. Clear air echo top extended to 4 km AGL, 1.5 km above the inversion level. A wind jet structure was evident just beneath this inversion.

Satellite Operations

Although normal GOES/VAS operations were terminated near 2100 GMT due to RISOP, the VAS data coverage to 1900 GMT should complement the aircraft and radar operations.

Aircraft Operations

The U-2 conducted a MAMS/HIS mission over the SPACE region from 1730 to 2000 GMT. Five flight legs were oriented north to south and separated in the east-west direction by ~65 km. The flight was made over a well developed cumulus mediocris cloud field and had CP-2 radar support.

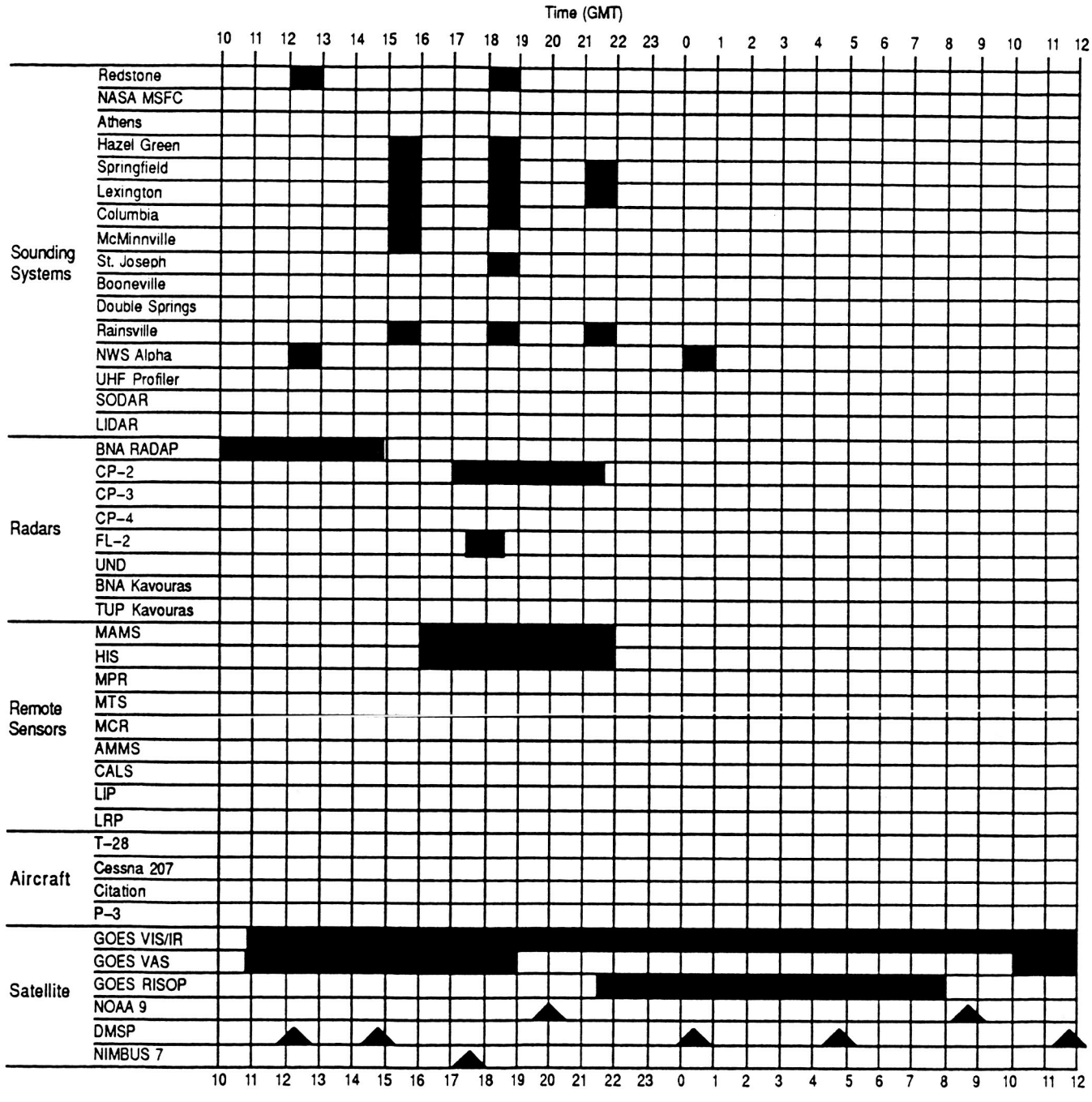
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5-550-7-8(14)

Day: SUNDAY
Date: 6/15/86
Julian Day: 166–167

Hourly Collection of COHMEX Data



		Comments
Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 1, 2, 4 & 5
	TVA ADAS	MISSING STATIONS 22, 26, 27, 30, 40, 56 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

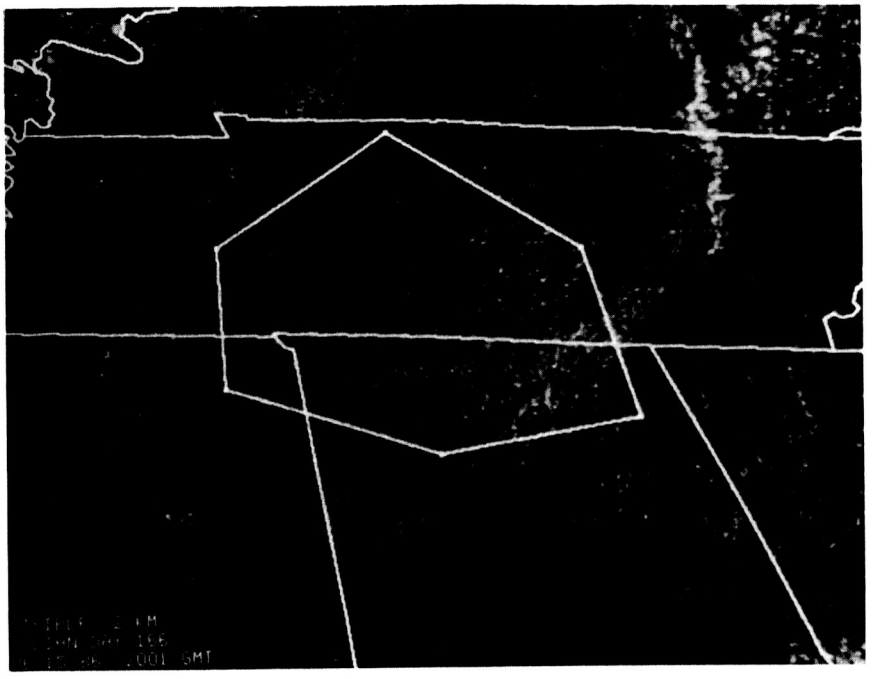


Fig. 3.2-14b. Visible 2 km GOES Central satellite image for 15 June 1986 2001 GMT

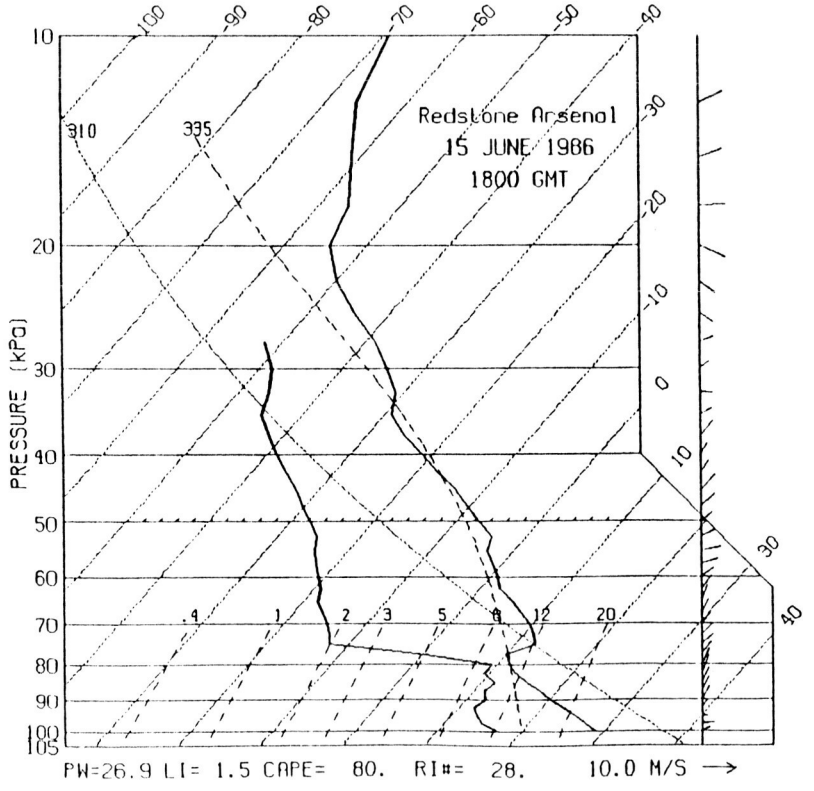


Fig. 3.2-14c. Redstone Arsenal, AL, rawinsonde sounding for 15 June 1986 1800 GMT

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Fig. 3.2-14d. Twenty-four hour lightning strike density plot for 15-16 June 1986

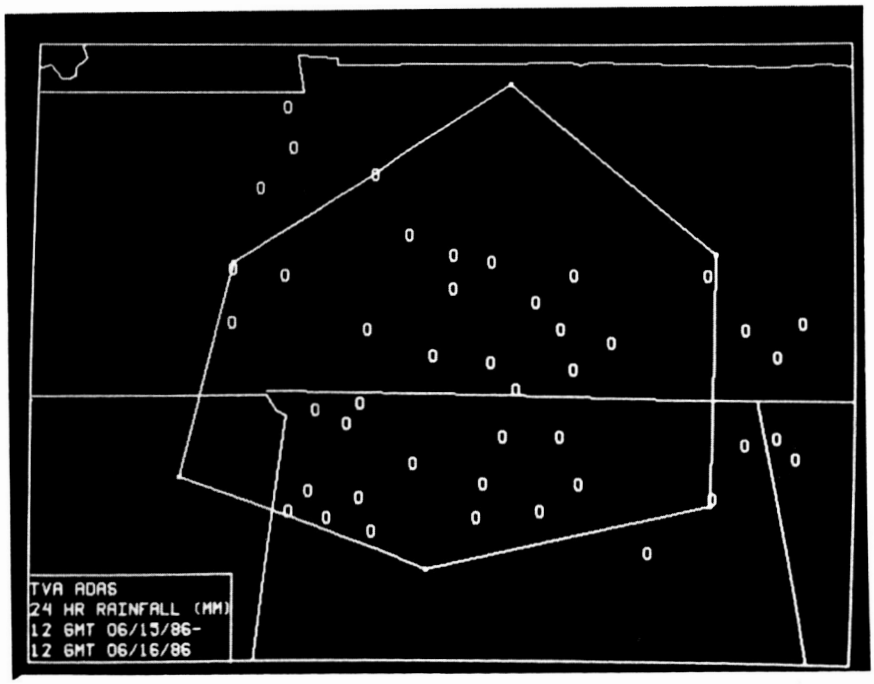


Fig. 3.2-14e. Twenty-four hour TVA ADAS rainfall totals (mm) for 15-16 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

16 June 1986

Synoptic Conditions

Dry conditions remained over the SPACE area, but greater low level moisture increased late in the day over the western mesonet. The subsidence inversion present on the three previous days was absent on the 1800 GMT RSA sounding. Surface flow was weak and generally southwesterly in response to anticyclonic flow around a surface high centered over the western Atlantic. Air flow aloft increased to 5-10 m s^{-1} at low levels but remained weak above 600 mb. A weak and slowly moving short wave trough was located over eastern Oklahoma at 1200 GMT. A cold front located 700 km to the northwest was expected to enter the SPACE region by tomorrow morning. Afternoon surface temperature and dewpoint values ranged from 29 and 18 °C over the western mesonet to 30 and 15 °C over the eastern border.

Cloud/Precipitation Overview

Clear morning skies gave way to scattered cloudiness during the afternoon hours. Cumulus mediocris clouds about 1 km deep developed by late morning. The visible satellite loop indicated a maximum convective cloud area around local noon. Dissipation of the cumulus field occurred by late afternoon, and some cirrus were observed by early evening over the western horizon. No precipitation was recorded over the SPACE region.

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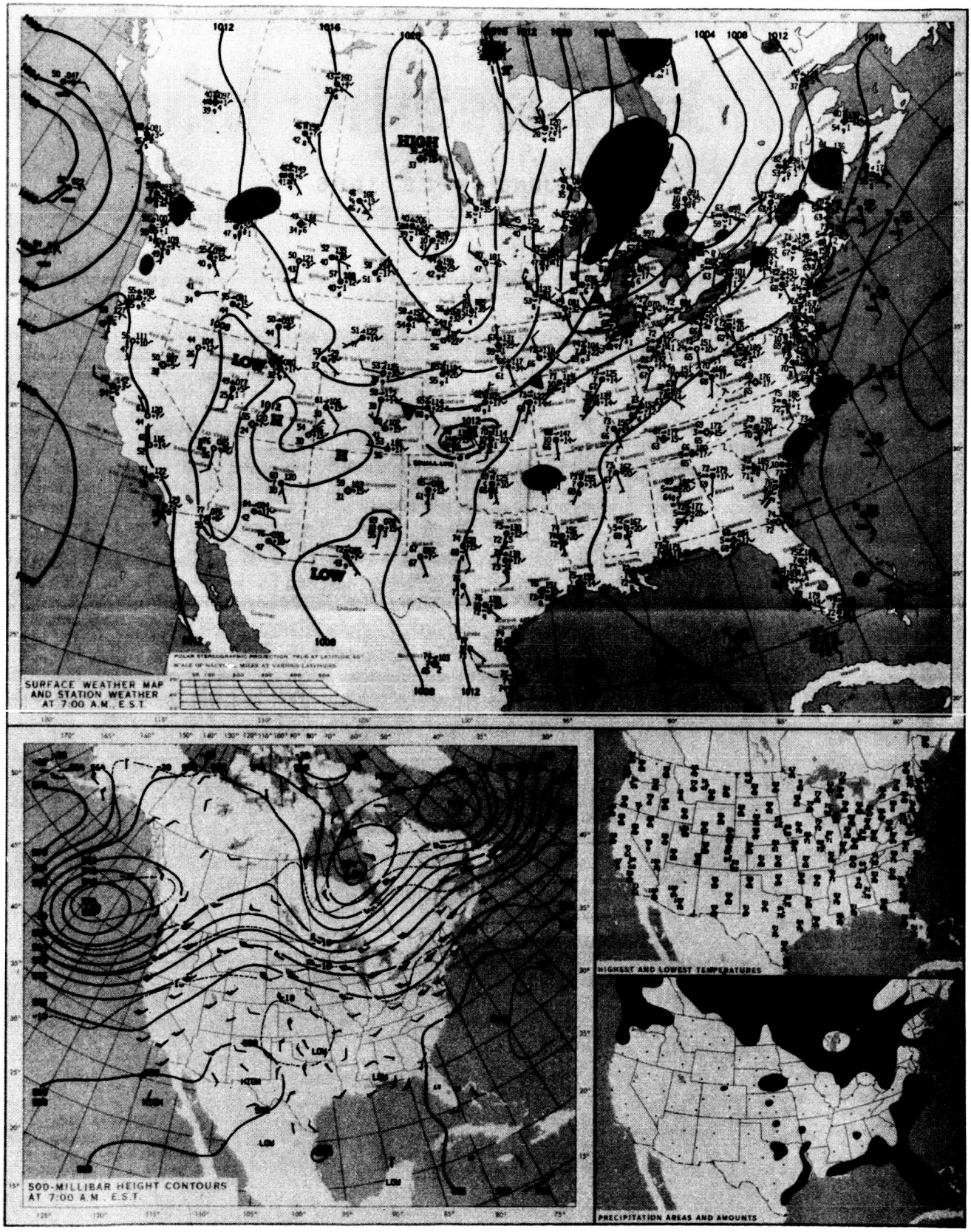


Fig. 3.2-15a. Synoptic weather conditions for 16 June 1986 1200 GMT

OPERATIONAL SUMMARY

16 June 1986

Rawinsonde Operations

The normal 1200 and 1800 GMT soundings were taken from RSA.

Radar Operations

The NCAR Doppler radars were on 1730 GMT standby, but precipitating convection failed to develop and no data were recorded.

Satellite Operations

VAS data were collected until 1600 GMT, and RISOP was started at 1830 GMT.

Aircraft Operations

No operations.

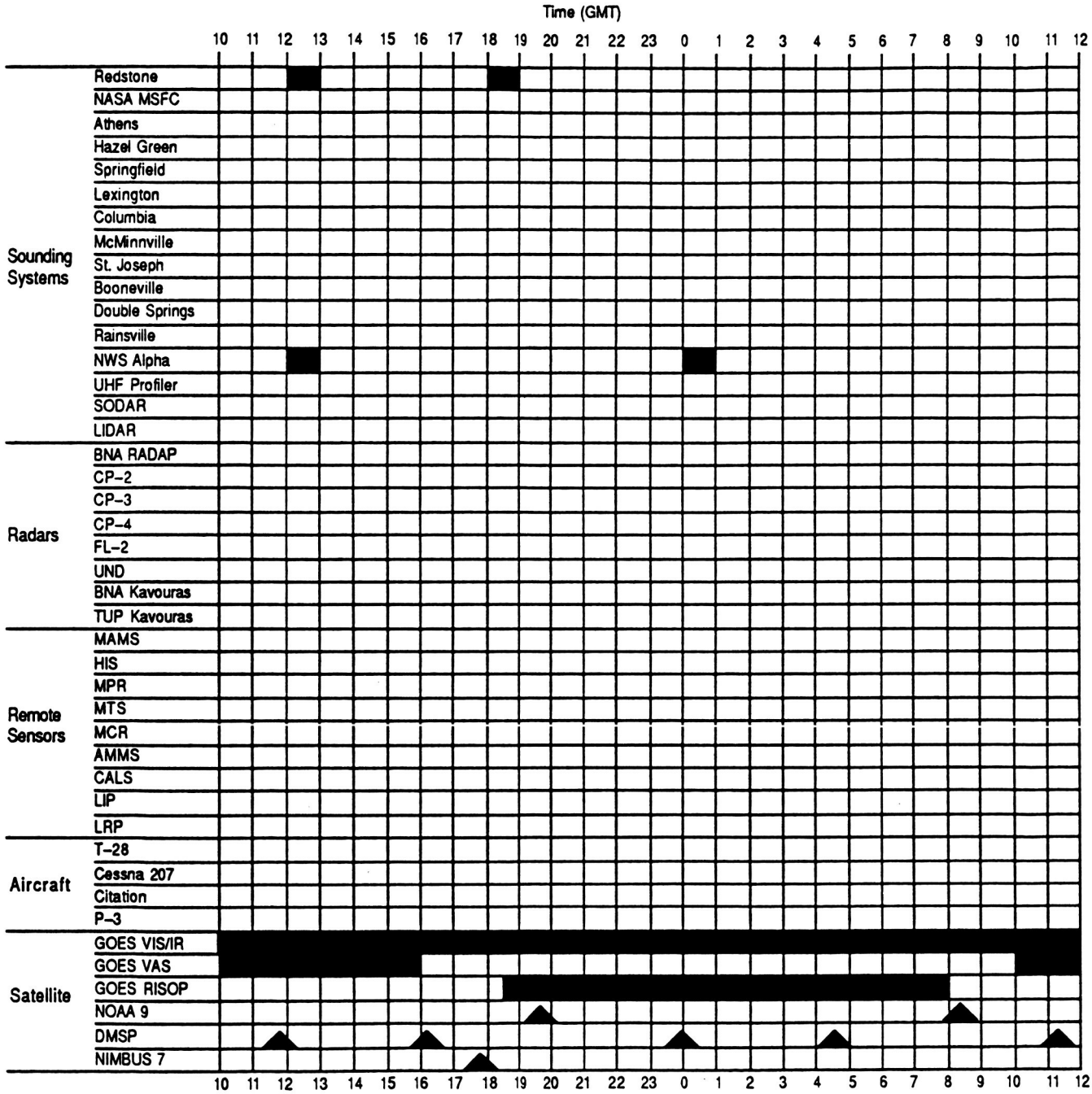
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5-550-7-8(15)

Day: MONDAY
Date: 6/16/86
Julian Day: 167–168

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 2, 4 & 5
	TVA ADAS	MISSING STATIONS 21, 22, 26, 27, 28, 40 & 56
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

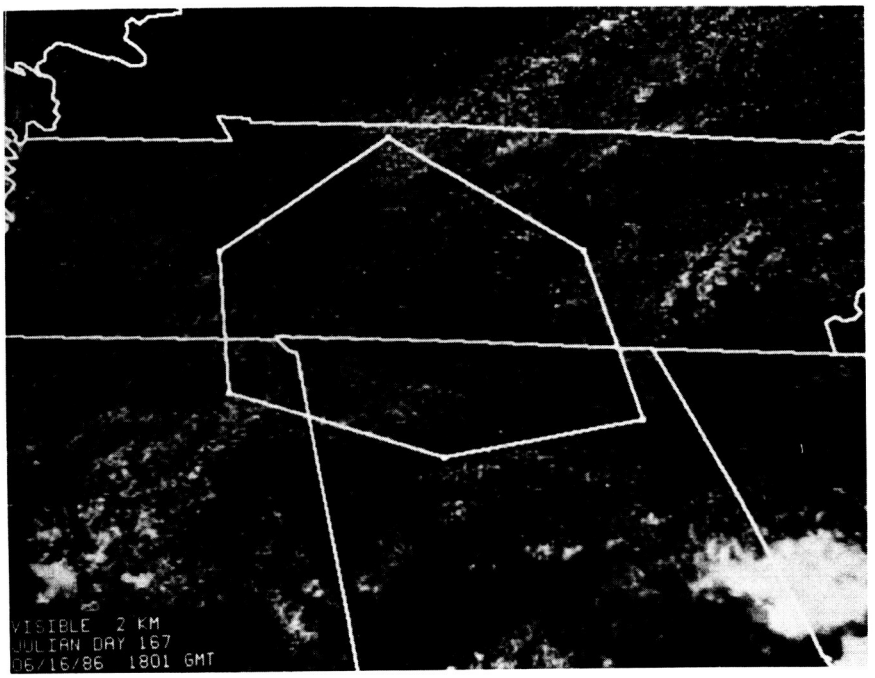


Fig. 3.2-15b. Visible 2 km GOES Central satellite image for 16 June 1986 1801 GMT

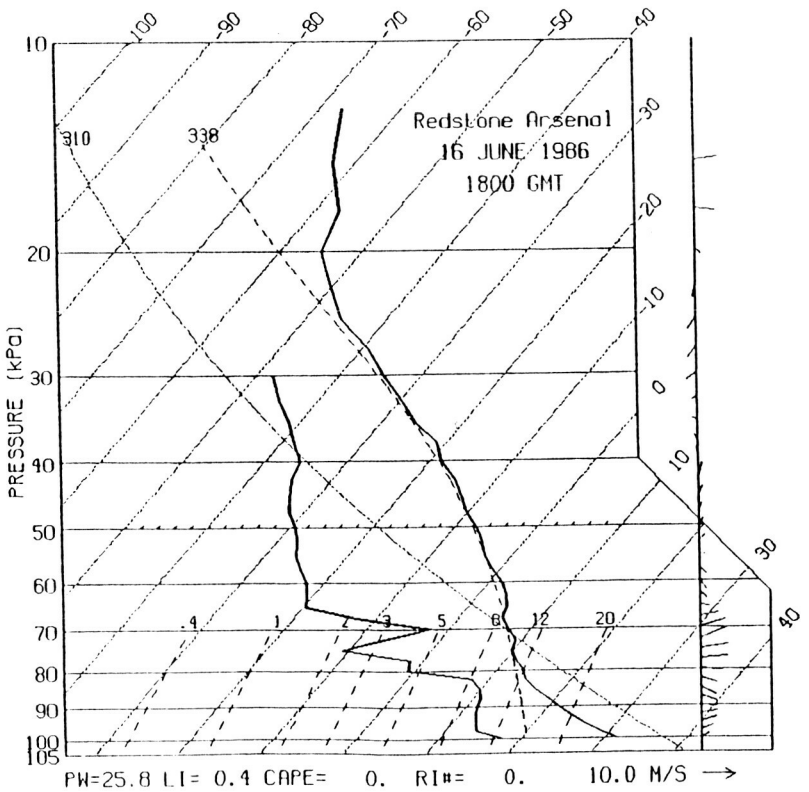


Fig. 3.2-15c. Redstone Arsenal, AL, rawinsonde sounding for 16 June 1986 1800 GMT

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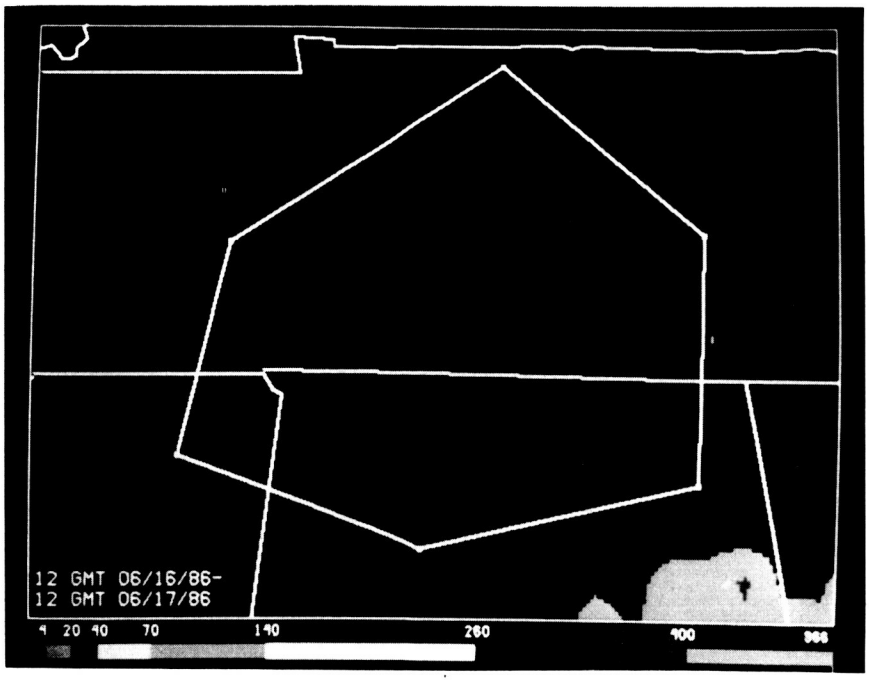


Fig. 3.2-15d. Twenty-four hour lightning strike density plot for 16-17 June 1986

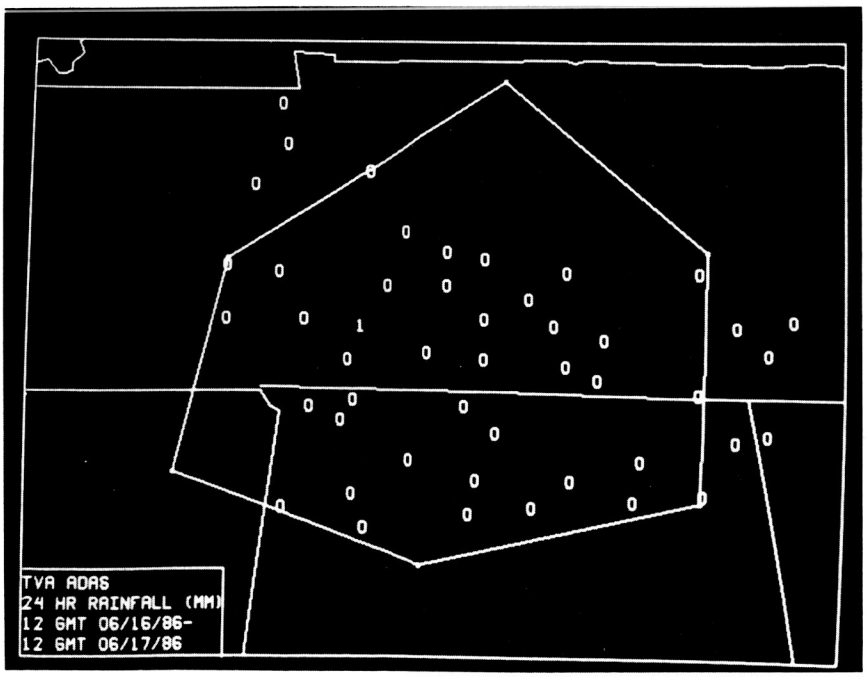


Fig. 3.2-15e. Twenty-four hour TVA ADAS rainfall totals (mm) for 16-17 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

17 June 1986

Synoptic Conditions

A cold front approaching from the north during the early morning hours moved through the SPACE mesonet during the afternoon. The 1200 GMT RSA sounding showed weak winds which veered smoothly from northwesterly at low levels to very light northerly at middle levels. Precipitable water amounts increased to 40 mm, 15 mm greater than yesterday. Examination of the 1200 and 0000 GMT 500 mb charts revealed that a subtle short wave trough moved over the SPACE mesonet around 0800 GMT. However, temperatures aloft remained cool (-8 to -9 °C at 500 mb over the mesonet) and LI values at both BNA and RSA were -3 to -4, indicating some potential for deep convection. Strong storms did in fact form along a segment of the cold front in south-central Tennessee by early afternoon. During the morning hours winds shifted from westerly to northerly ahead of the front with no change in temperature or moisture (reason unknown). Maximum temperature and dewpoint values during the afternoon were ~31 °C and ~21 °C, respectively.

Cloud/Precipitation Overview

Cumulus clouds developed by midmorning from relatively rapid surface heating, under mostly clear skies. By late morning the cumulus had attained depths of about 1 km in the HSV area. By 1700 GMT towering cumulus were beginning to appear both along and ahead of the cold front. First echoes were observed around 1720 GMT about 80 km north of CP-2 in some deep convection that had developed along the cold front. Shortly after, isolated small echoes appeared 50 km ahead of the front over the MIST/FLOWS network around 1745 GMT, but these in contrast were not as deep nor as tall as cells within the convective line along the cold front. The isolated cells ahead of the front subsequently weakened while those along the cold front intensified, eventually producing strong surface winds and heavy rain over the MIST/FLOWS mesonet. The evolution of this convective line, which was highly multicellular, appeared to be highly influenced by low level outflow. Outflow speeds of more than 20 m s^{-1} were measured by both surface mesonet and Doppler radar. Some of the cells in the line exhibited pronounced rotation at middle levels. The pre-frontal precipitating convective clouds, although much smaller, also exhibited a multicellular structure. It would appear that the multiple Doppler data from these is of good quality. Rainfall amounts were isolated but locally heavy over the southern SPACE mesonet, despite having missed the TVA ADAS raingages (see Fig. 3.2-16e).

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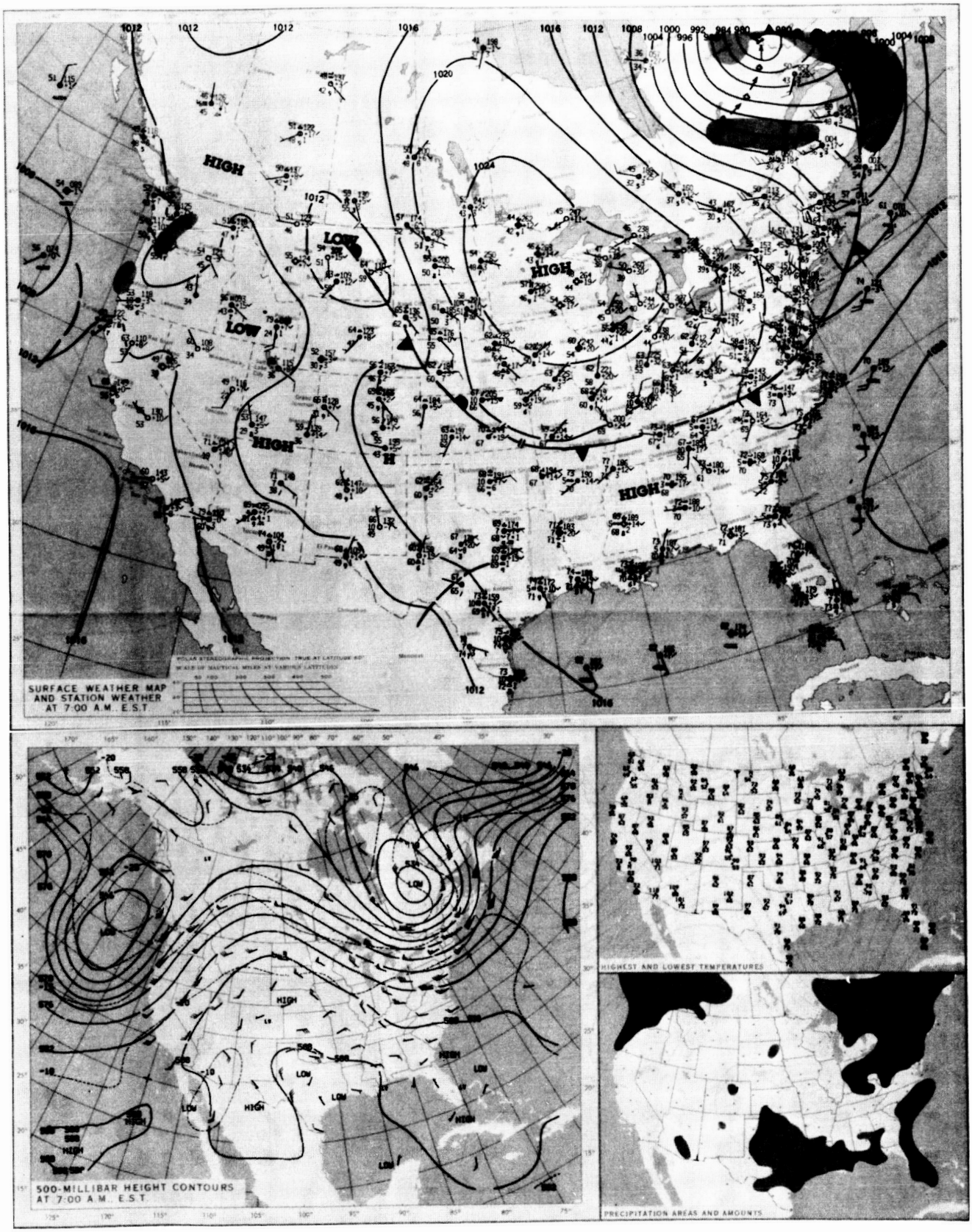


Fig. 3.2-16a. Synoptic weather conditions for 17 June 1986 1200 GMT

OPERATIONAL SUMMARY

17 June 1986

Rawinsonde Operations

Serial launches were made from the Arsenal (RSA and MSFC) at 1200, 1800, 2100, and 0000 GMT. These soundings should provide a representative storm environment and should have captured the cold frontal passage. No other soundings were released.

Radar Operations

Surveillance scans were recorded by CP-4 from 1720 to 1800 GMT. Doppler radars then conducted 2.5-min scans from 1800 to 1840 GMT on a small multicell echo in the southeast lobe of the CP-3/4 baseline target. From 1840 to beyond 2200 GMT, the Doppler radars conducted miscellaneous scans on an intense convective line which passed through the MIST/FLOWS network. These scans were single Doppler from 1840 to 1945 GMT, limited dual Doppler with CP-2 and CP-3 from 1945 to 2100 GMT, and single Doppler thereafter. CP-4 was down from 1945 to 2115 GMT as the line moved over the MIST/FLOWS mesonet. RADAP data were acquired but apparently not archived by BNA personnel. However, limited ICRAD products were recorded at NASA/MSFC.

FL-2 personnel noted two microburst and one gust front near the MIST/FLOWS mesonet. Low level outflow winds up to 25 m s^{-1}, strong midlevel rotation and strong reflectivity factor (up to 65 dBZ) were also observed. At one point near 1939 GMT, a radial velocity differential of ~60 m s^{-1} was observed near echo top in association with high reflectivity at lower levels.

Satellite Operations

GOES VAS products were generated through 2130 GMT and should be valuable in portraying differences in thermodynamic structure across the cold front. Cloud cover was generally small over most of the SPACE mesonet. RISOP was not effected today.

Aircraft Operations

No operations.

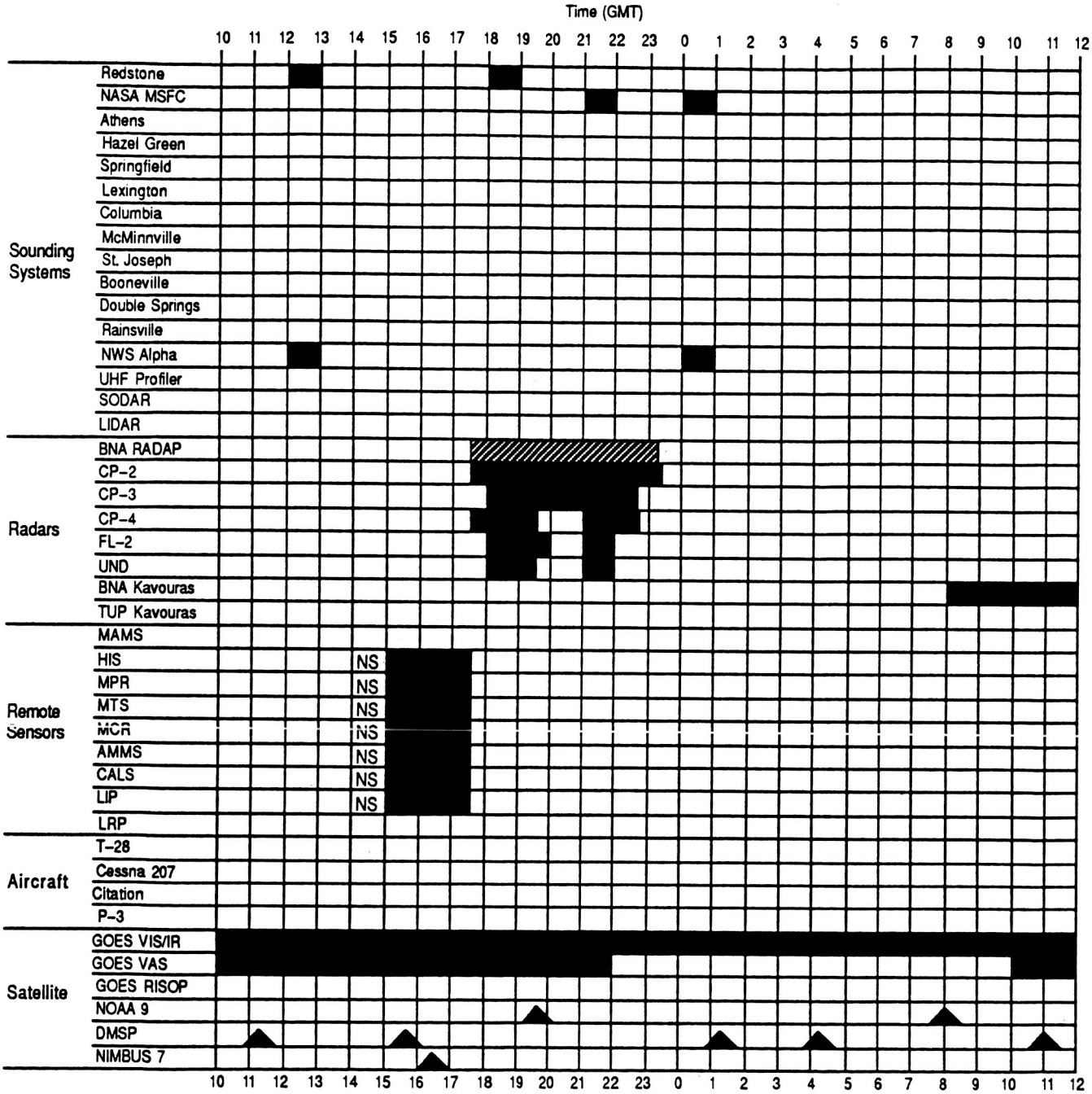
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5-550-7-8 (16)

Day: TUESDAY
Date: 6/17/86
Julian Day: 168–169

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 2, 4, & 5
	TVA ADAS	MISSING STATIONS 11, 12, 26, 27, 40, 45, & 56
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL



Fig. 3.2-16b. Visible 2 km GOES Central satellite image for 17 June 1986 2031 GMT

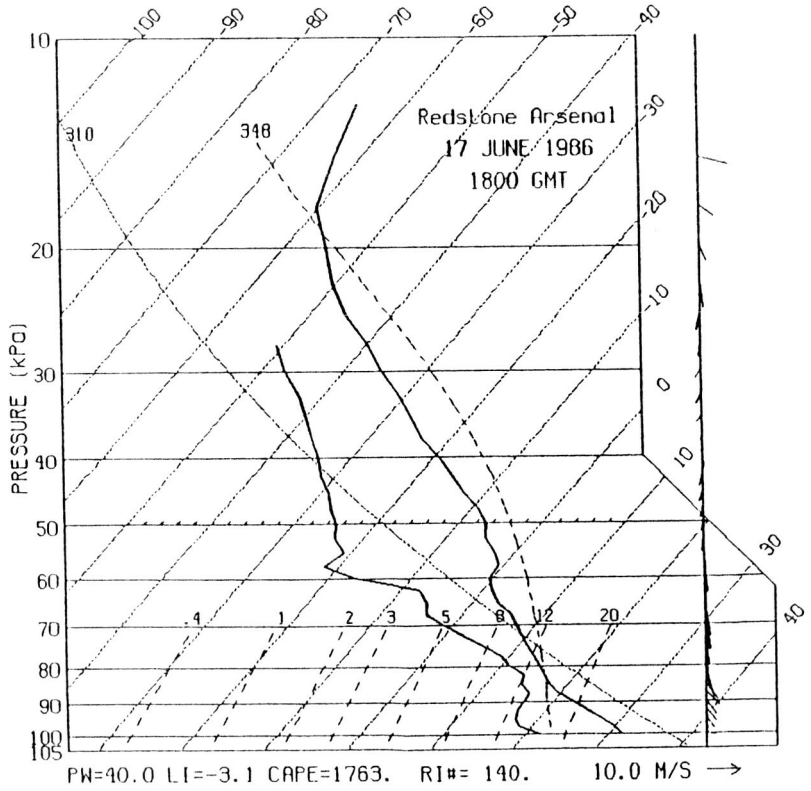


Fig. 3.2-16c. Redstone Arsenal, AL, rawinsonde sounding for 17 June 1986 1800 GMT

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Fig. 3.2-16d. Twenty-four hour lightning strike density plot for 17-18 June 1986

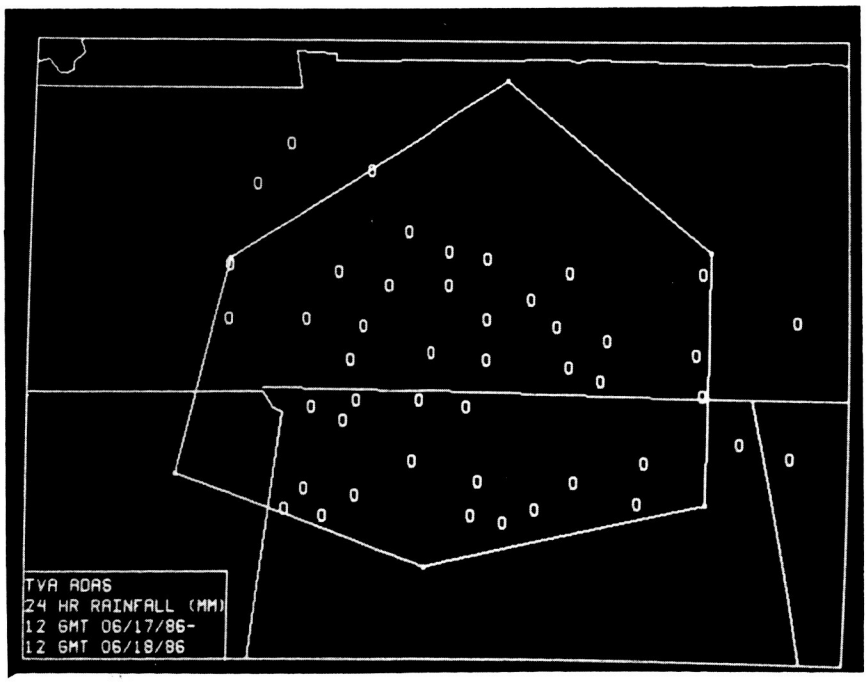


Fig. 3.2-16e. Twenty-four hour TVA ADAS rainfall totals (mm) for 17-18 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

18 June 1986

Synoptic Conditions

The post-frontal air brought much drier and more stable low level air over the SPACE mesonet. A strong inversion located near 850 mb prevented development of deep convection. Upper level flow was northeasterly throughout the lower troposphere and exhibited little vertical shear. By midafternoon the cold front had turned stationary over southern Alabama, and a broad anticyclone (surface to above middle levels) produced dry and stable conditions over the SPACE mesonet. Surface dewpoint temperatures ranged between 11 and 14 °C, while maximum surface temperatures peaked near 28 °C.

Cloud/Precipitation Overview

Few clouds were present over the SPACE region during the day, and no precipitation was recorded. Cirrus clouds were present in varying amounts in both morning and afternoon, increasing somewhat by early evening.

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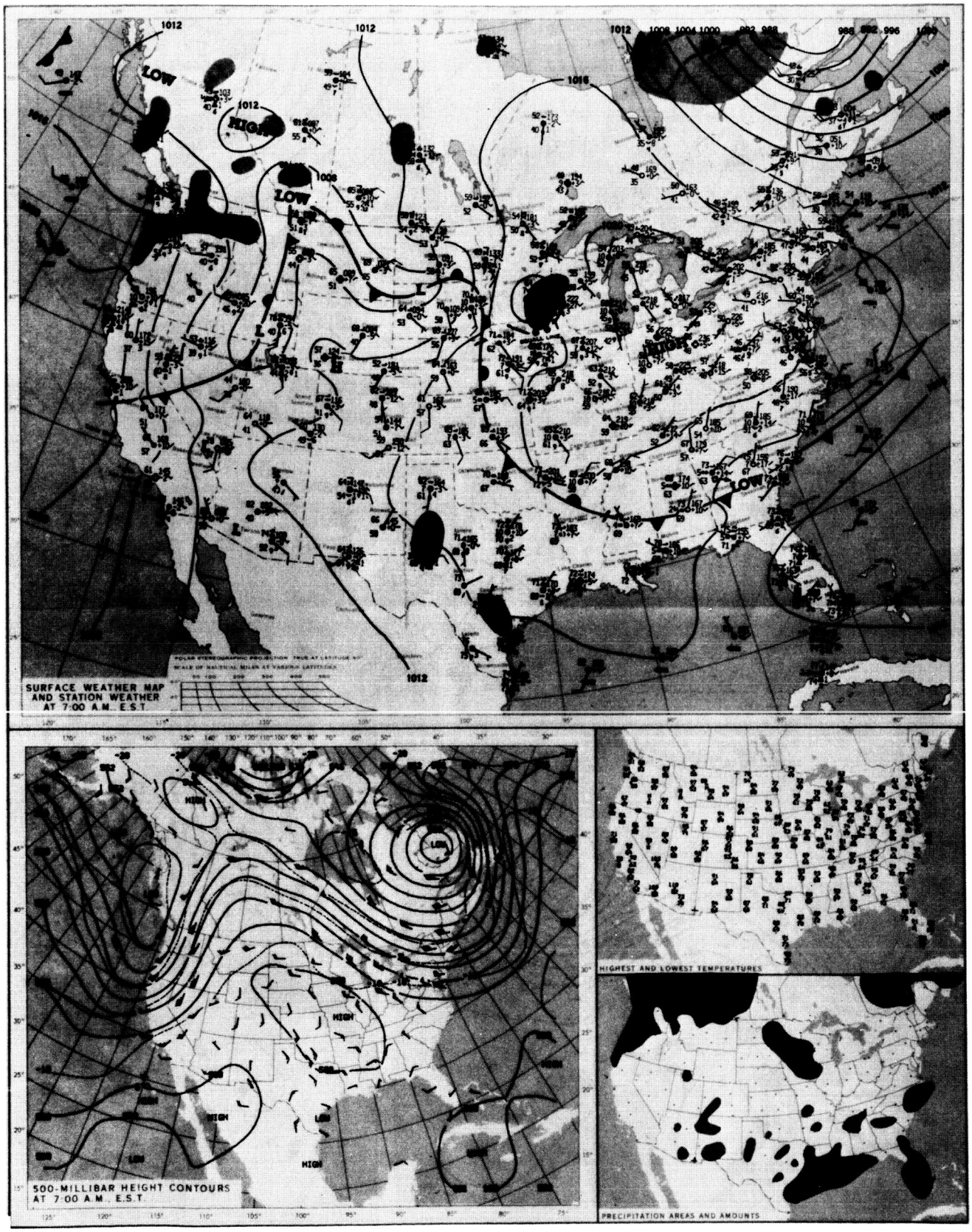


Fig. 3.2-17a. Synoptic weather conditions for 18 June 1986 1200 GMT

OPERATIONAL SUMMARY

18 June 1986

Rawinsonde Operations

Serial releases were made from the Redstone Arsenal (RSA and MSFC) at 1200, 1500, 1630 and 1800 GMT. No other special releases were made in support of the U-2 flight.

Radar Operations

No special radar operations were conducted. Although RADAP was operational, data were not archived (only ICRAD is available) and no echoes were observed.

Satellite Operations

GOES VAS products were acquired through 1600 GMT and overlap the U-2 flight by only one hour.

Aircraft Operations

A U-2 MAMS mission was conducted over the SPACE network from 1500 to 1800 GMT. The flight consisted of 7 east-west legs separated by ~50 km. The second flight leg corresponds close in both time and space to the 1500 GMT balloon release from NASA.

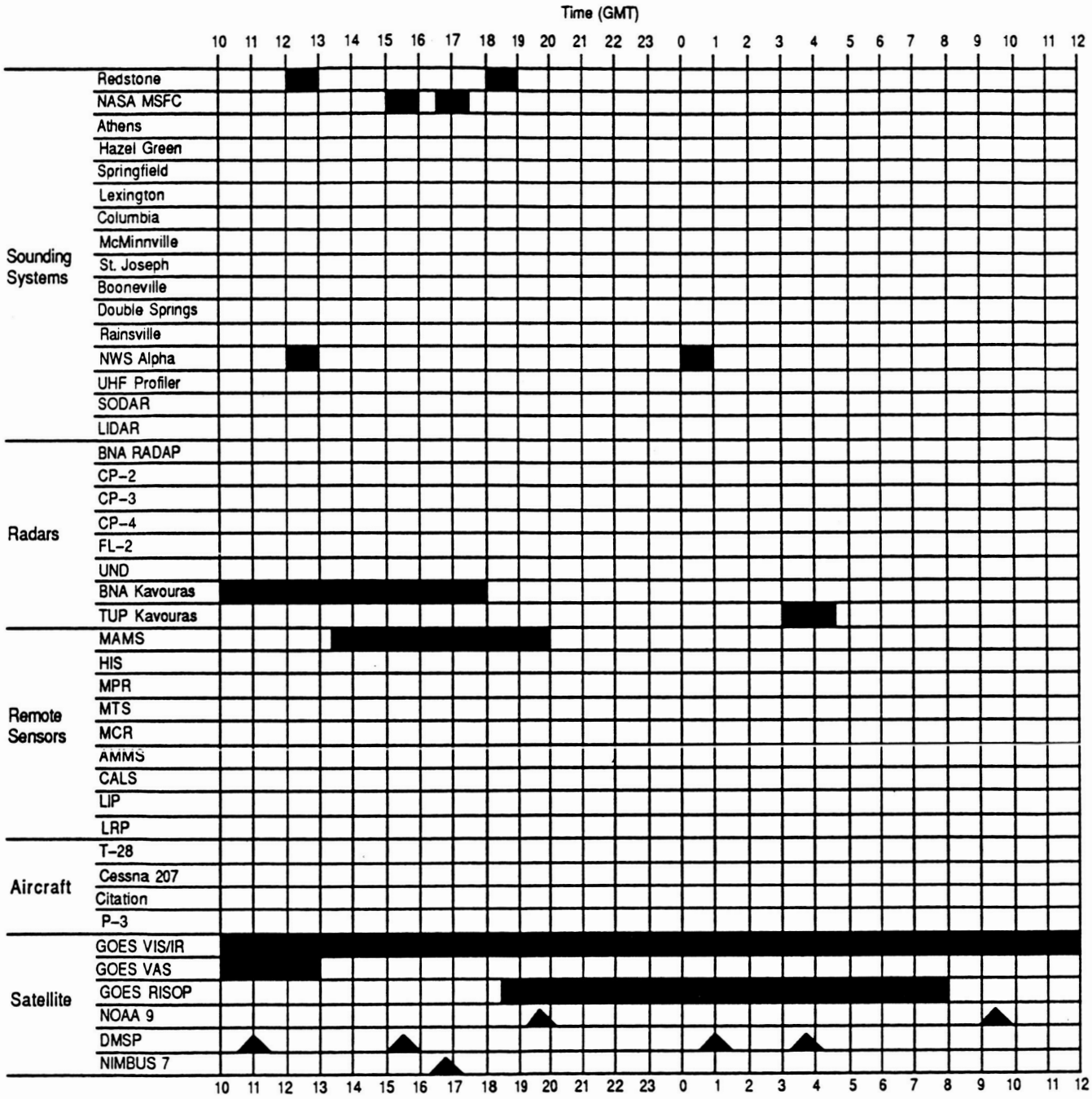
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5-550-7-8 (17)

Day: WEDNESDAY
Date: 6/18/86
Julian Day: 169–170

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 2, 4, & 5
	TVA ADAS	MISSING STATIONS 12, 16, 22, 26, & 40
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

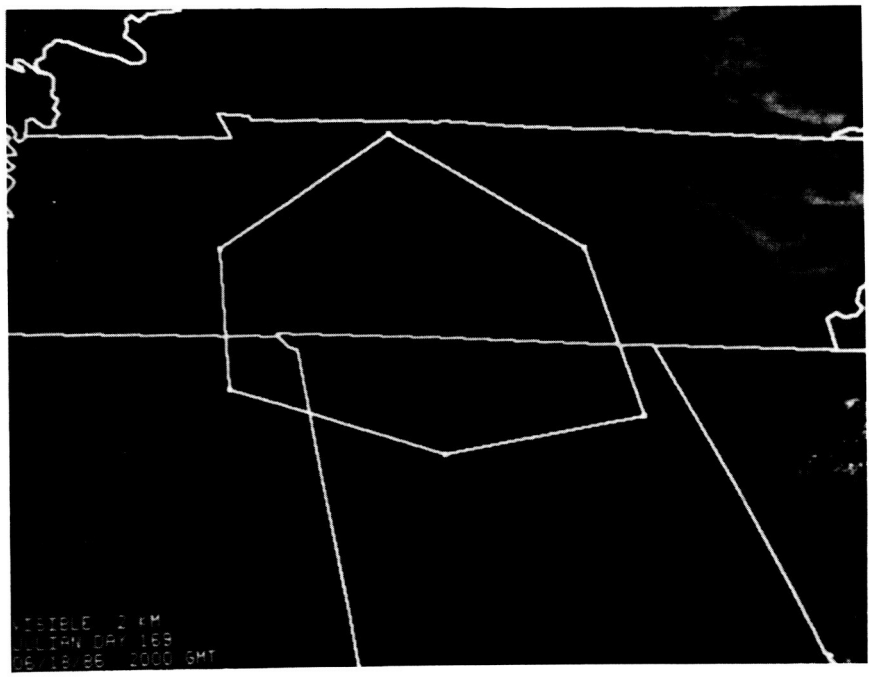


Fig. 3.2-17b. Visible 2 km GOES Central satellite image for 18 June 1986 2000 GMT

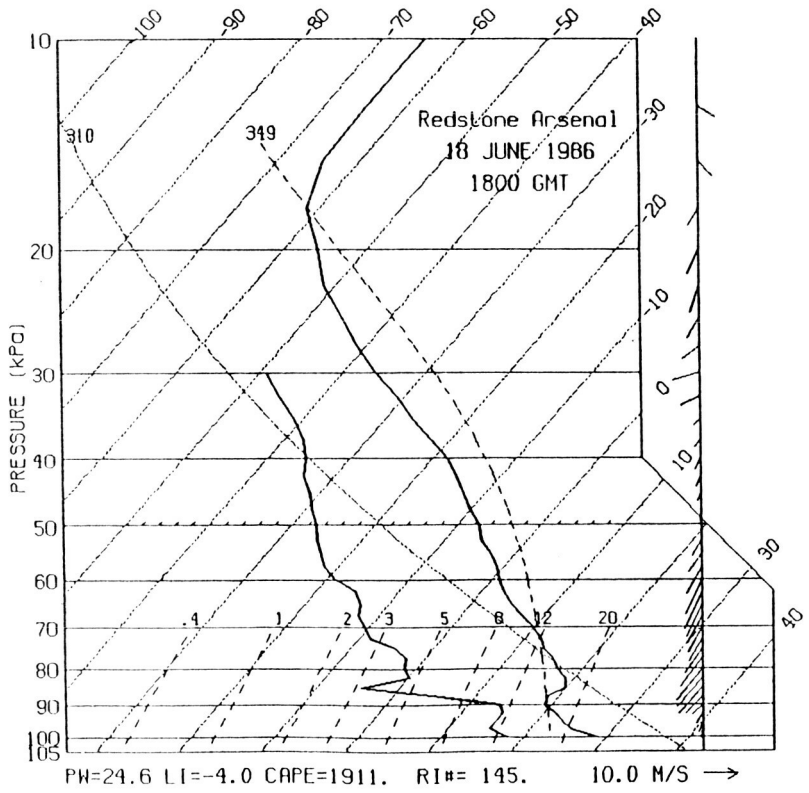


Fig. 3.2-17c. Redstone Arsenal, AL, rawinsonde sounding for 18 June 1986 1800 GMT

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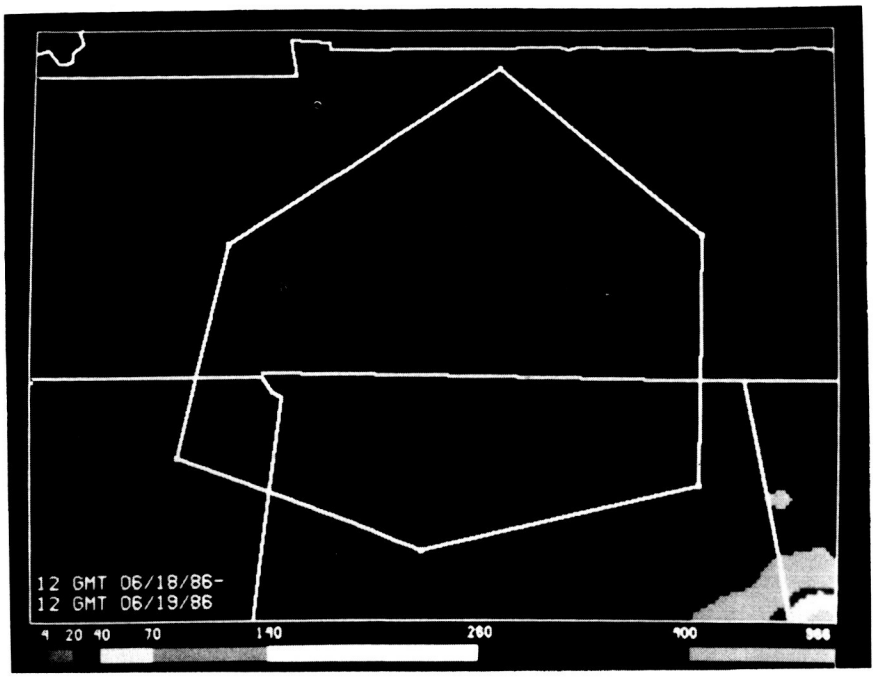


Fig. 3.2-17d. Twenty-four hour lightning strike density plot for 18-19 June 1986

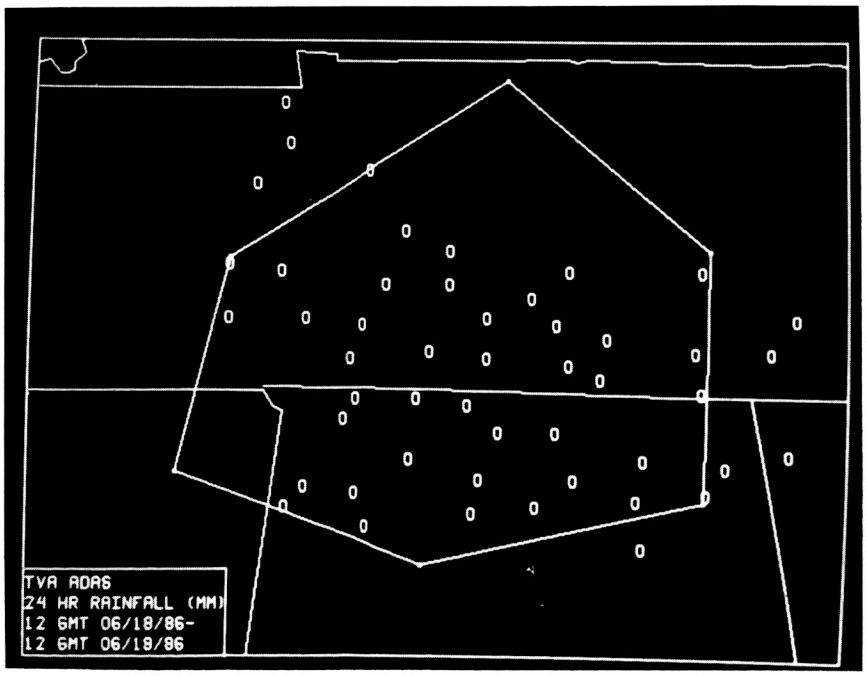


Fig. 3.2-17e. Twenty-four hour TVA ADAS rainfall totals (mm) for 18-19 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

19 June 1986

Synoptic Conditions

A broad and deep anticyclone continued to dominate the entire Southeast throughout the day. However, the strong subsidence which stabilized yesterday's environment appeared to be absent today. Total precipitable water increased to 29 mm and CAPE on the 1800 GMT RSA sounding increased to 1250 J kg^{-1}. A significant north-south variation in low level moisture was indicated in the surface mesonet. Winds, however, remained light and variable over the mesonet. Afternoon surface temperature and dewpoint values over the SPACE mesonet were 31 and 14 °C over the north, and 30 and 20 °C over the south.

Cloud/Precipitation Overview

A cumulus mediocris cloud field formed by late morning and existed over much of the southern beta network by early afternoon. A few enhanced cloud streets were apparent in visible satellite images. Only a few isolated small cells attained cumulonimbus status during the afternoon, one group along the southeastern border of the mesonet, and another along the western border. Echoes associated with these cumulonimbus were small in horizontal extent but nonetheless attained intensities of 50 dBZ. Other areas of cumulonimbus activity were located over the Appalachian Mountains of eastern Tennessee and over central to southern Alabama.

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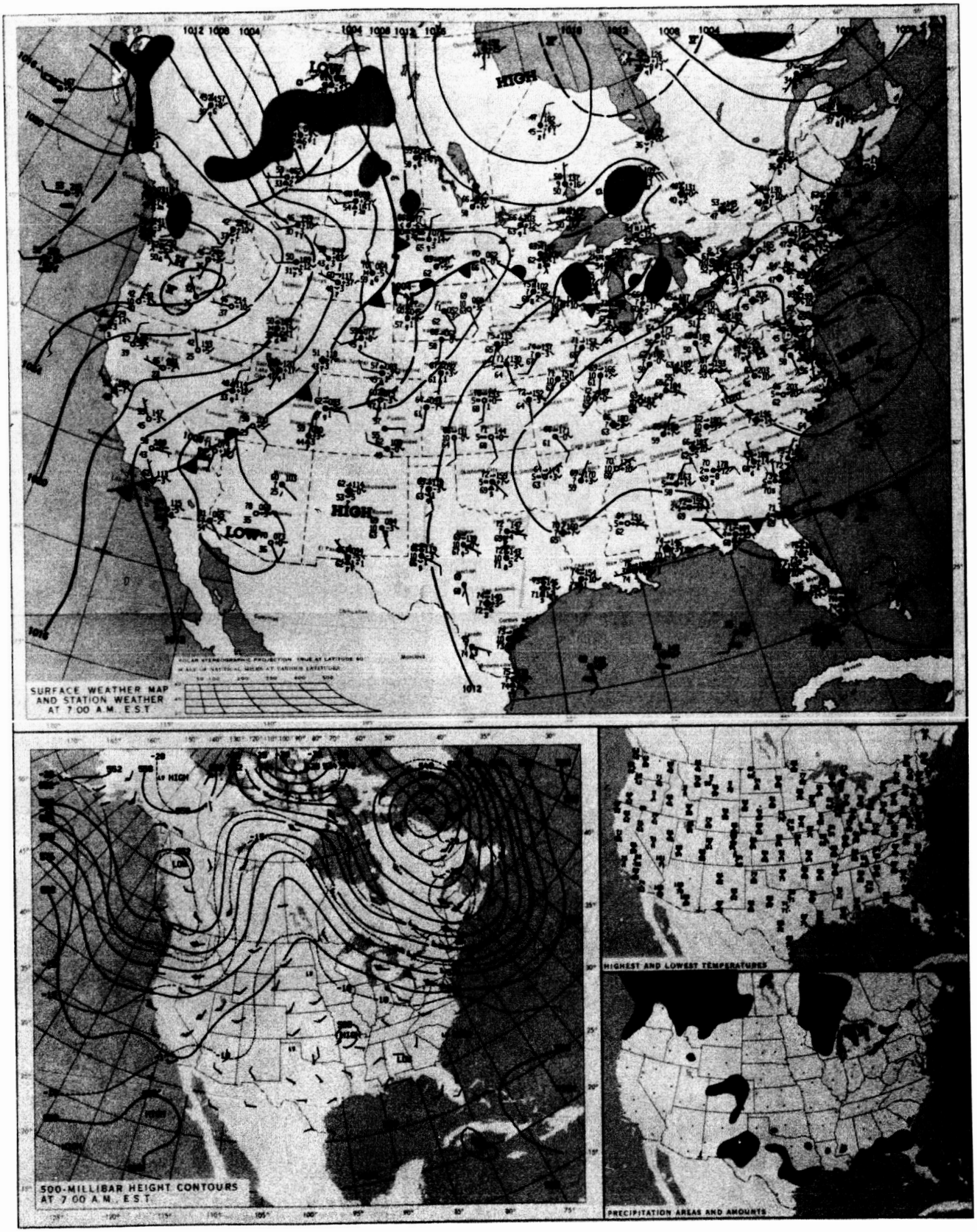


Fig. 3.2-18a. Synoptic weather conditions for 19 June 1986 1200 GMT

OPERATIONAL SUMMARY

19 June 1986

Rawinsonde Operations

A full Meso-beta rawinsonde operation between 1500 and 0000 GMT was run in support of the clear air aircraft mission.

Radar Operations

Data were collected from CP-4 (and a bit from CP-2) from about 1900 to 2315 GMT. Although most of the collection was done in clear air, some data on small precipitating cells were acquired in PPI and RHI mode on a few echoes within 115 km range. Clear air echo was detected by CP-4 out to ~60 km, and a wind discontinuity was apparent in RHI scans near 4 km AGL.

Satellite Operations

GOES VAS products were generated between 1330 and 2130 GMT and fully cover the time period of the high level aircraft overflights and the rawinsonde operations. This should provide a complete clear air (only a few isolated showers) sounding data set.

Aircraft Operations

The ER-2 (1430-1715 GMT) and U-2 (1530-1815 GMT) conducted a coordinated clear air mission over the SPACE mesonet. Flight legs over the beta network consisted of east-west segments separated by 50-60 km.

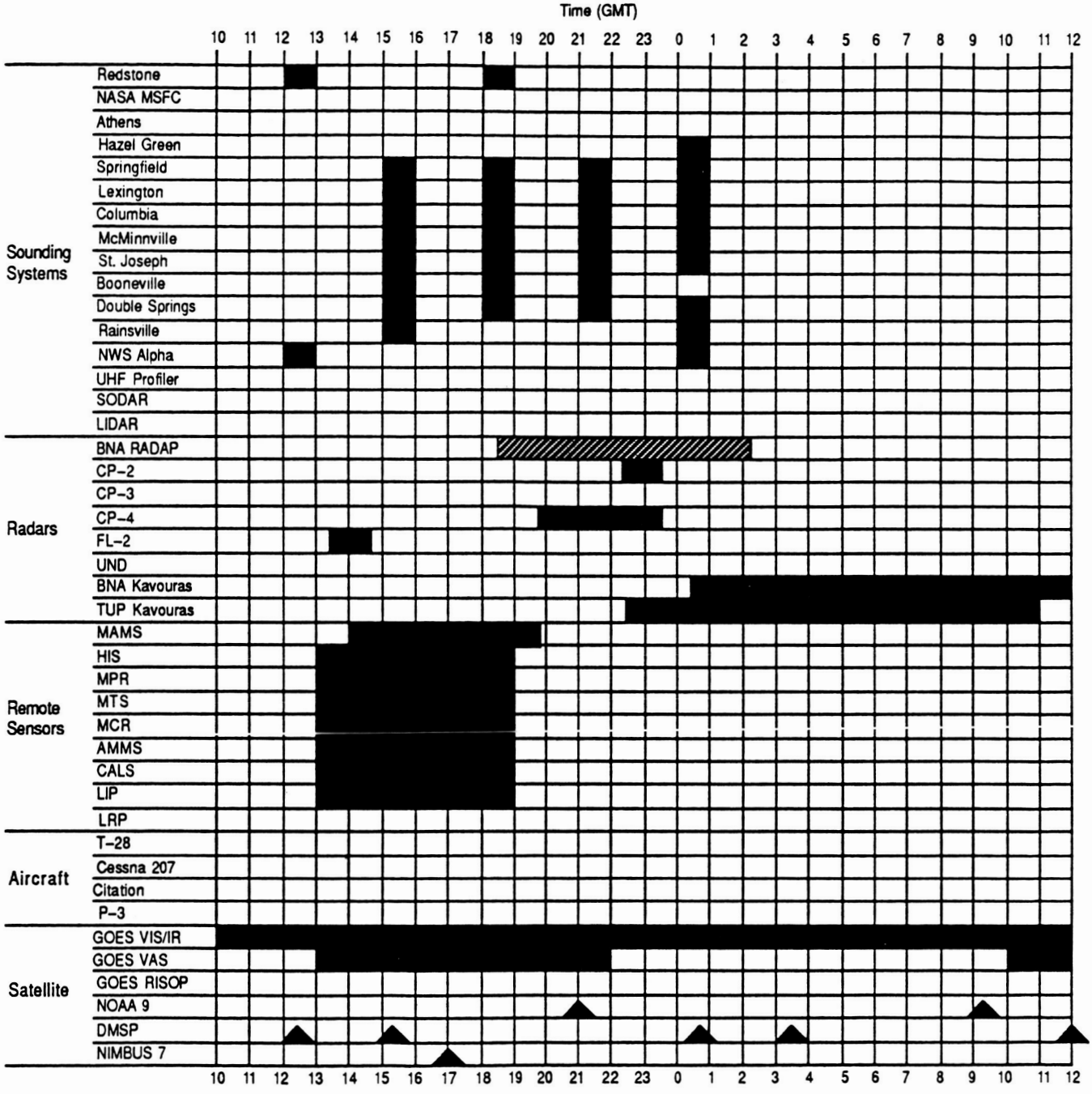
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5-550-7-8 (18)

Day: THURSDAY
Date: 6/19/86
Julian Day: 170–171

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 12, 16, 22, 40, 44, & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL



Fig. 3.2-18b. Visible 2 km GOES Central satellite image for 19 June 1986 2301 GMT

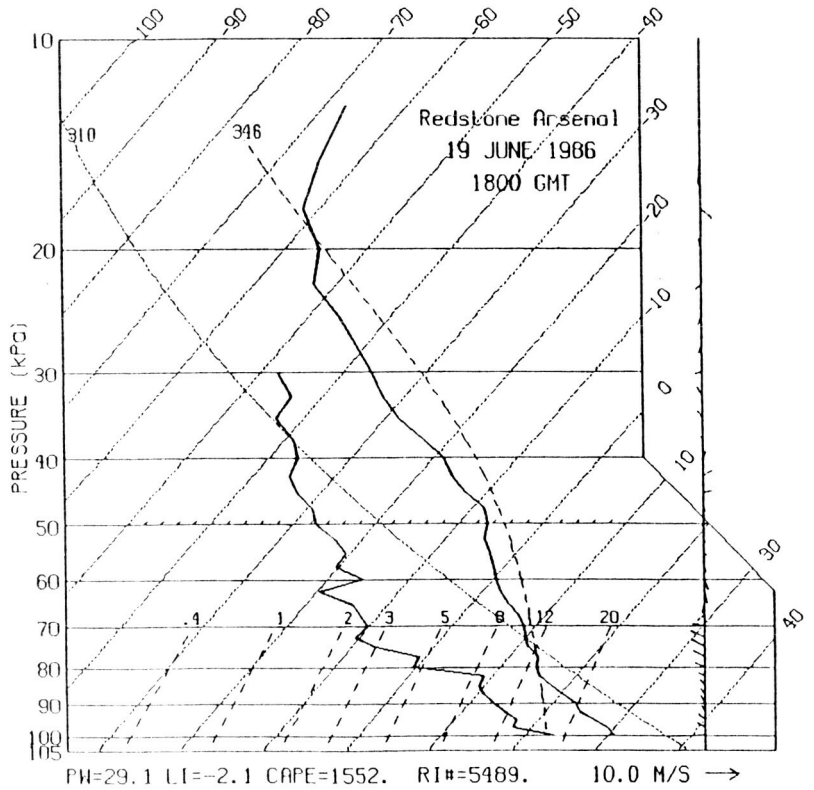


Fig. 3.2-18c. Redstone Arsenal, AL, rawinsonde sounding for 19 June 1986 1800 GMT

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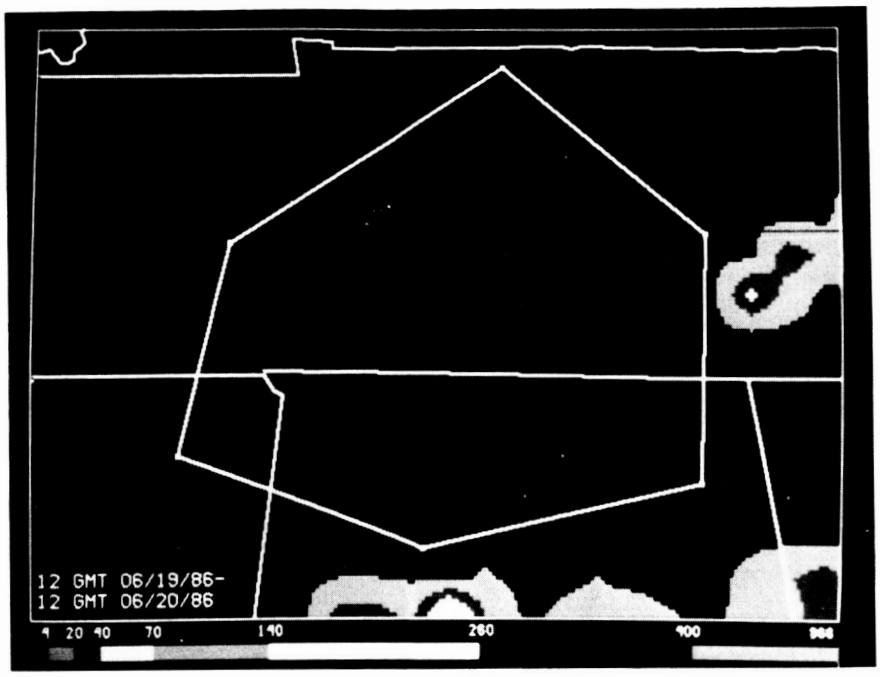


Fig. 3.2-18d. Twenty-four hour lightning strike density plot for 19-20 June 1986

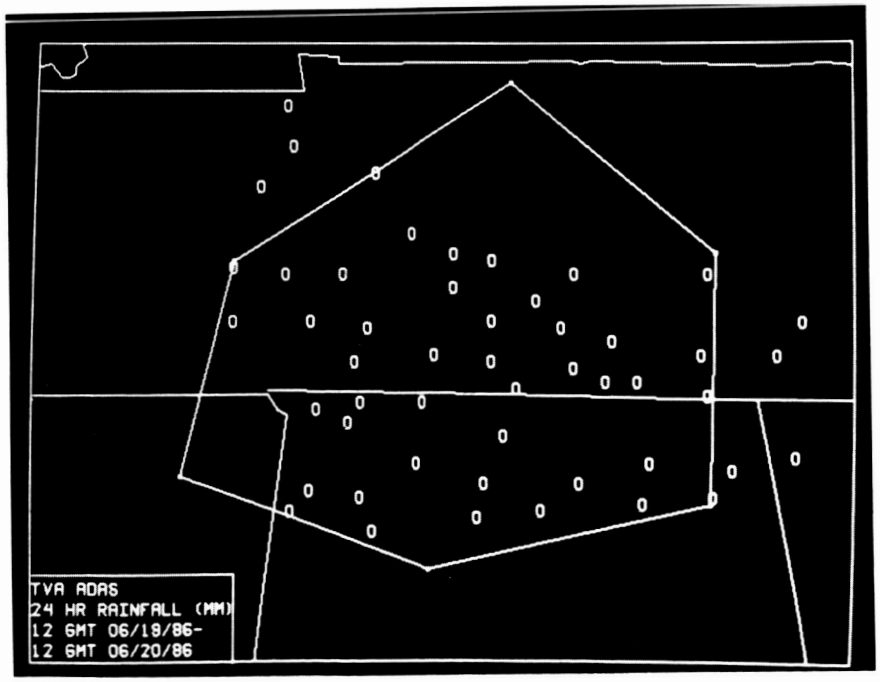


Fig. 3.2-18e. Twenty-four hour TVA ADAS rainfall totals (mm) for 19-20 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

20 June 1986

Synoptic Conditions

Very weak southerly flow at low levels continued to transport low level moisture into the SPACE mesonet during the day. The upper level ridge remained prominent to the west and north over the Midwest, and the surface anticyclone, located to the east of the upper level ridge, continued to weaken. This weakening, combined with increased low level moisture, served to destabilize the atmosphere. Precipitable water values climbed over yesterday's values to 33 mm, and LI values dropped to near -4 over the region. At the surface, afternoon temperatures climbed to 31-32 °C and dewpoints were more horizontally uniform in the 18-20 °C range.

Cloud/Precipitation Overview

Isolated echoes appeared from 2000 to 2300 GMT primarily over the southern beta mesonet south of HSV. Several echoes observed from CP-4 attained intensities of 50-60 dBZ and echo tops to 11-12 km despite showing little structure in radial velocity. First convective clouds formed around noon. A maximum cloud field occurred around 2000 GMT.

Notes:

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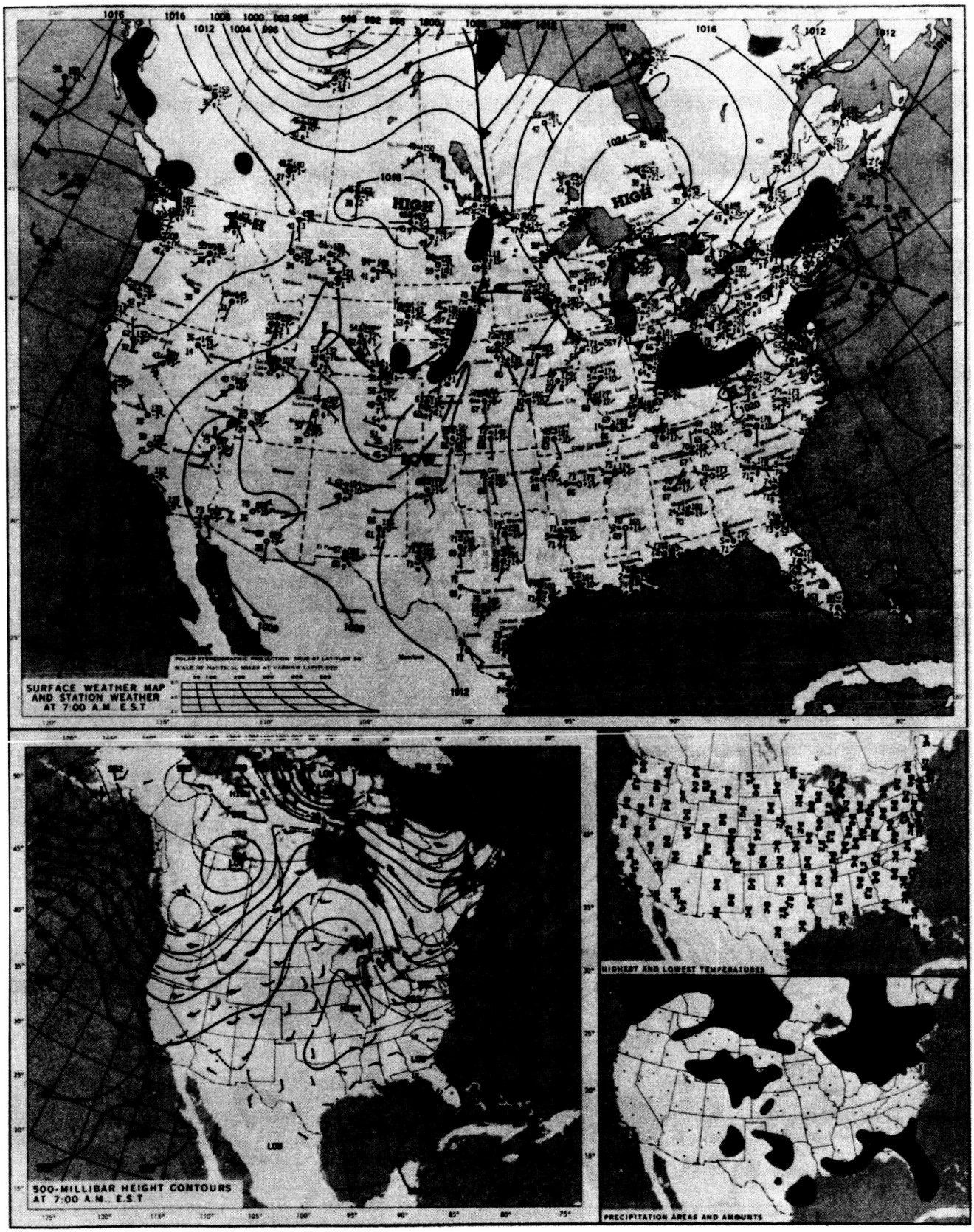


Fig. 3.2-19a. Synoptic weather conditions for 20 June 1986 1200 GMT

OPERATIONAL SUMMARY

20 June 1986

Rawinsonde Operations

Releases were made from 4 stations forming the southern triangles (where precipitating convection subsequently formed) at 1500, 1800 and 2100 GMT. Thus, these should provide details on the environmental thermodynamic profiles and kinematic conditions.

Radar Operations

Radar operations consisted primarily of surveillance and RHI scans from 1848 to 2318 GMT. A marginal quality dual Doppler scan was conducted on a weakly precipitating towering cumulus, located along an apparent Lake Wheeler breeze zone, from 2040 to 2115 GMT.

Satellite Operations

GOES VAS products were generated from 1000 to 2130 GMT and cover the time period of initiation and evolution of deep convection.

Aircraft Operations

No operations.

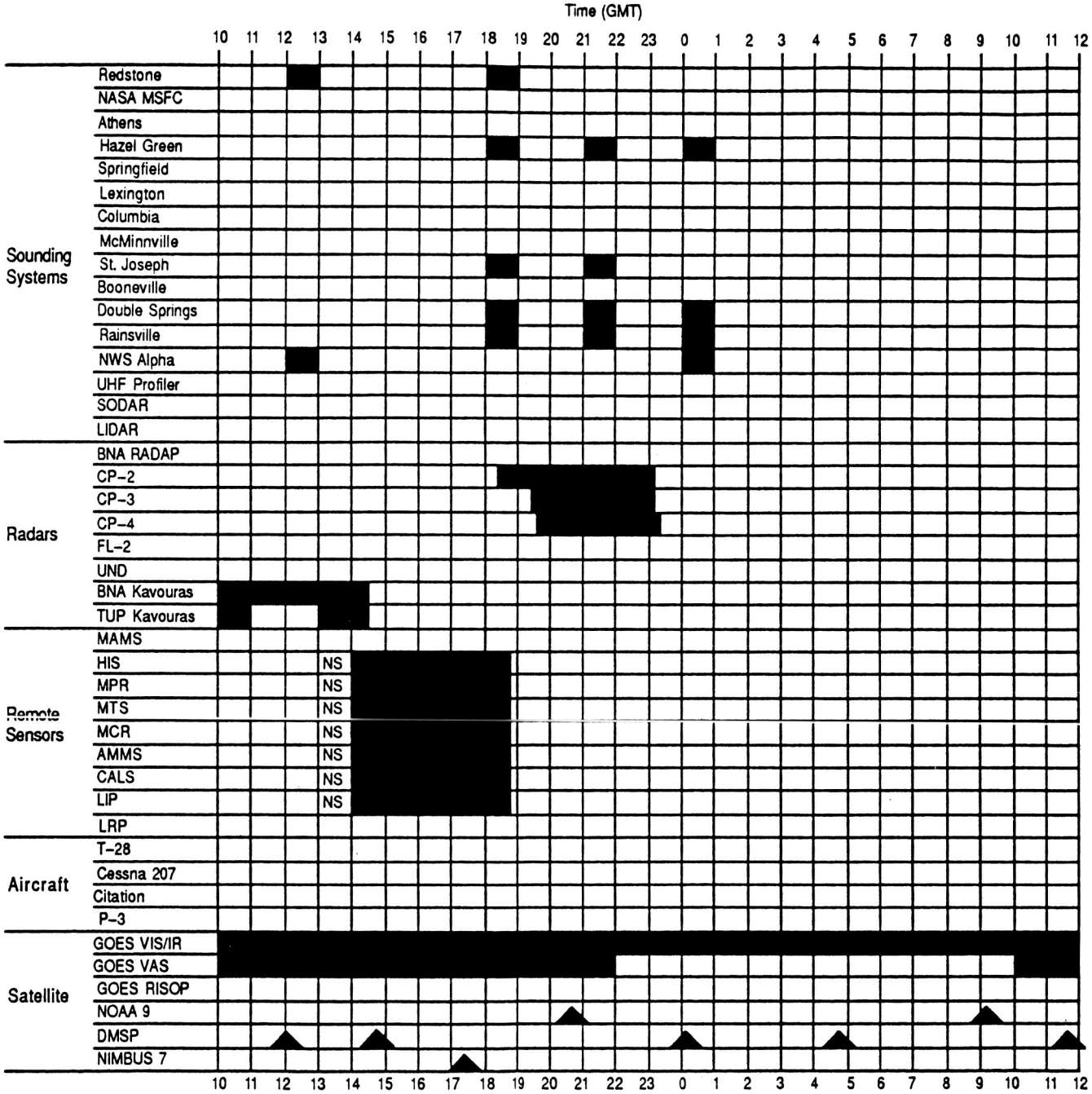
Notes:

5-550-7-8 (19)

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Day: FRIDAY
Date: 6/20/86
Julian Day: 171–172

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 3, 12, 16, 22, 40, & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL



Fig. 3.2-19b. Visible 2 km GOES Central satellite image for 20 June 1986 2101 GMT

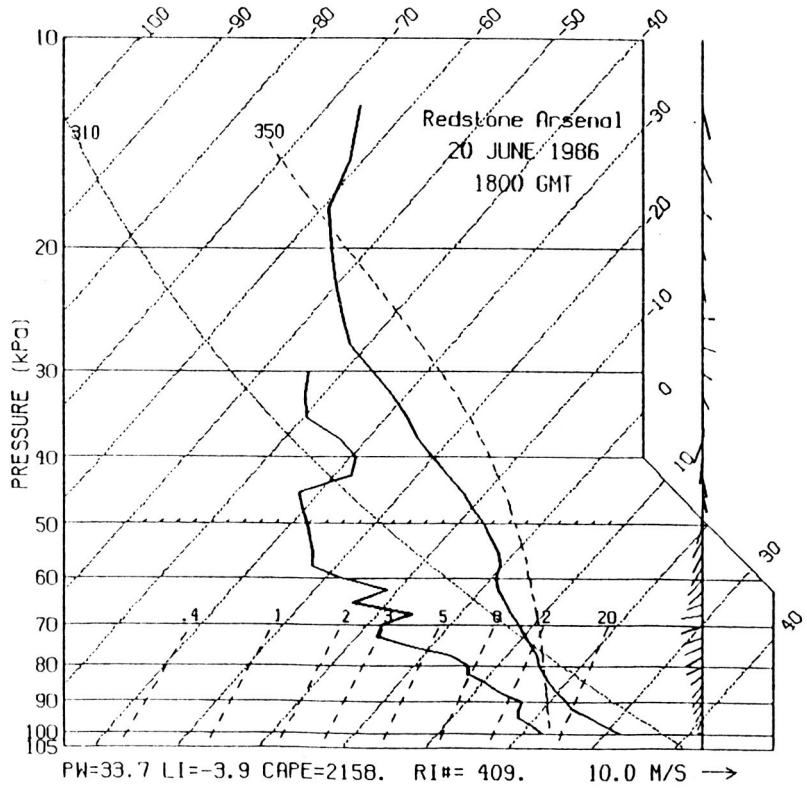


Fig. 3.2-19c. Redstone Arsenal, AL, rawinsonde sounding for 20 June 1986 1800 GMT

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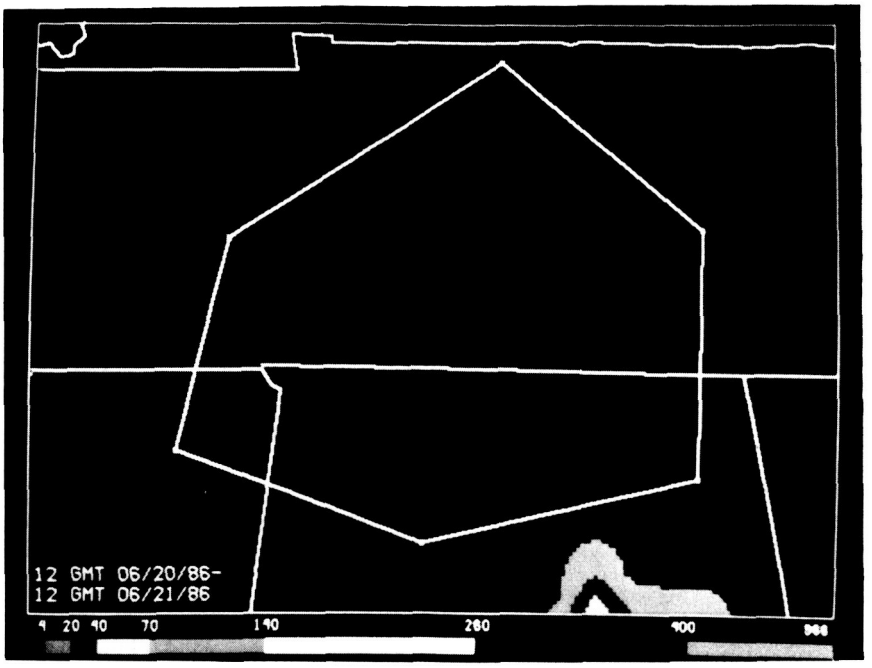


Fig. 3.2-19d. Twenty-four hour lightning strike density plot for 20-21 June 1986

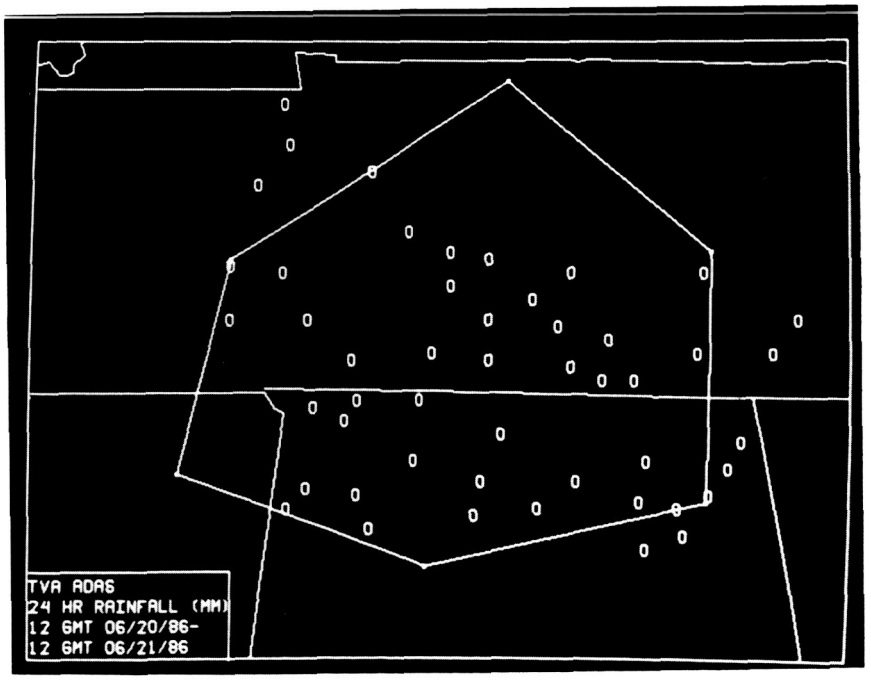


Fig. 3.2-19e. Twenty-four hour TVA ADAS rainfall totals (mm) for 20-21 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

21 June 1986

Synoptic Conditions

The upper level cutoff ridge continued its eastward progression from the previous days, moving over the west-central SPACE mesonet by the end of the day. Upper level winds were corresponding light and exhibited considerable variability in both space and time over the network. At the surface, a 1025 mb anticyclone located over New England pushed a weak cold front over the northeastern half of the mesonet. However, variations across the front were subtle and frontal influences appeared to be minimal. The 1800 GMT RSA sounding was considerably more stable at low levels than yesterday, apparently due to synoptic scale subsidence. Afternoon temperature and dewpoint values over the mesonet were 32-33 and 18-21 °C in the presence of weak northeast surface flow.

Cloud/Precipitation Overview

First cumulus appeared around noon, and were in general more prominent over the northern portion of the SPACE mesonet throughout the afternoon hours. Only one cumulonimbus system formed within the beta network 45 km east of CP-4 during the day. This was a multicell thunderstorm which formed over the mountains and then moved southward parallel to the ridge axis. This system was distinctly multicellular, attained reflectivity factor exceeding 60 dBZ, and appeared to produce significant outflow during its 3-h life cycle. Echo tops exceeded 13 km and RHI scans suggested a periodic bounded weak echo region within this storm.

Notes:

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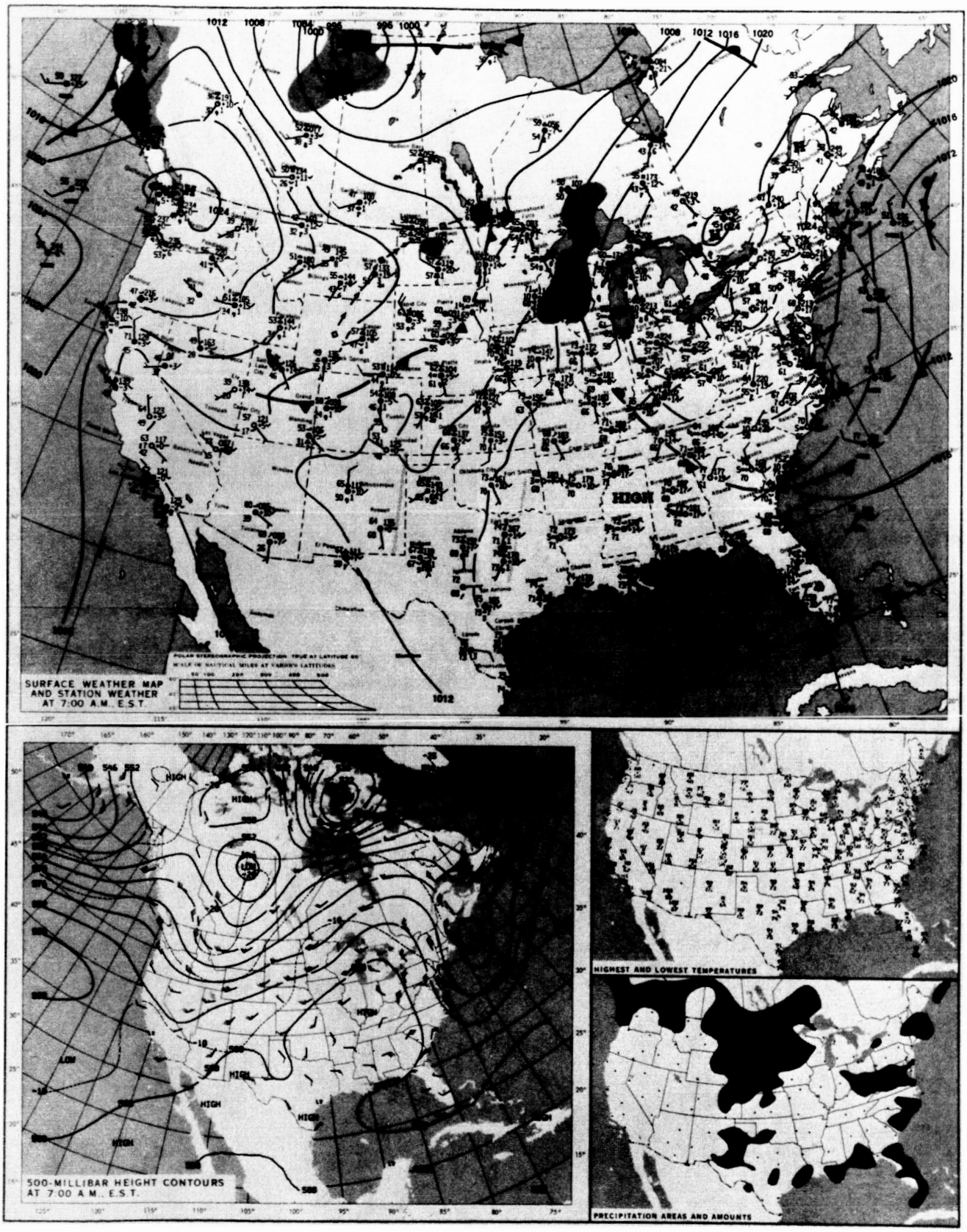


Fig. 3.2-20a. Synoptic weather conditions for 21 June 1986 1200 GMT

OPERATIONAL SUMMARY

21 June 1986

Rawinsonde Operations

The routine RSA 1200 and 1800 GMT soundings represent the only special releases. The 1800 GMT release should provide information on the environment representative of the isolated afternoon storm.

Radar Operations

The NCAR Doppler radars recorded data from 1730 to 2315 GMT. Prior to 2045 GMT, scans were primarily surveillance. From 2045 to 2315 GMT, a number of full volume sector scans were conducted on a multicell storm 45 km east of CP-4. Some limited quality dual Doppler scans should be available during the latter storm stages from 2240 to 2310 GMT.

Satellite Operations

GOES VAS products were acquired through 1430 GMT, after which RISOP was started.

Aircraft Operations

The T-28 aircraft conducted its first COHMEX test flight and actually made one penetration through the high reflectivity region of an actively growing cell within the isolated multicell thunderstorm described above.

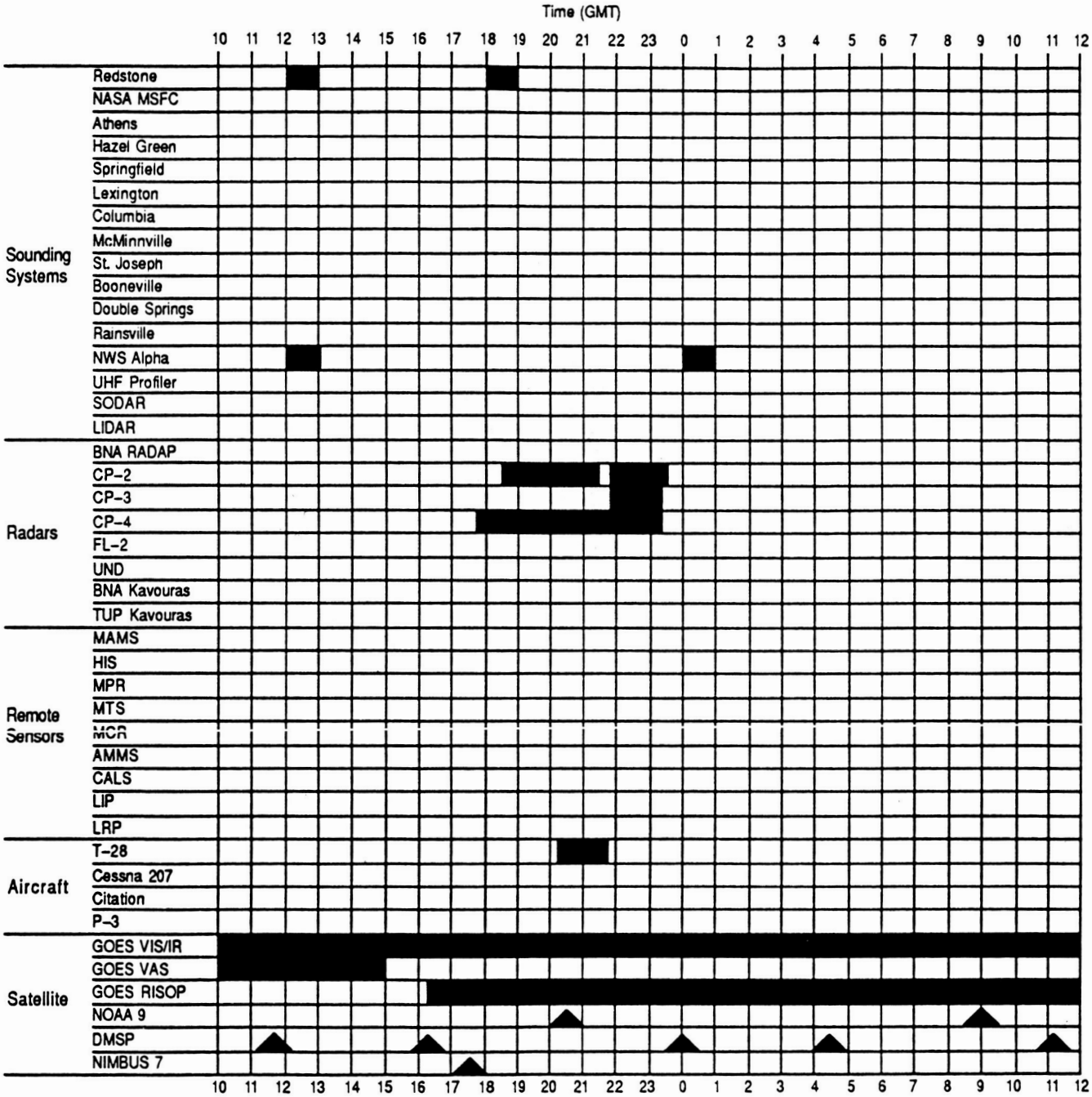
Notes:

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5-550-7-8(20)

Day: SATURDAY
Date: 6/21/86
Julian Day: 172–173

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 3, 5, 12, 16, 40, 44 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

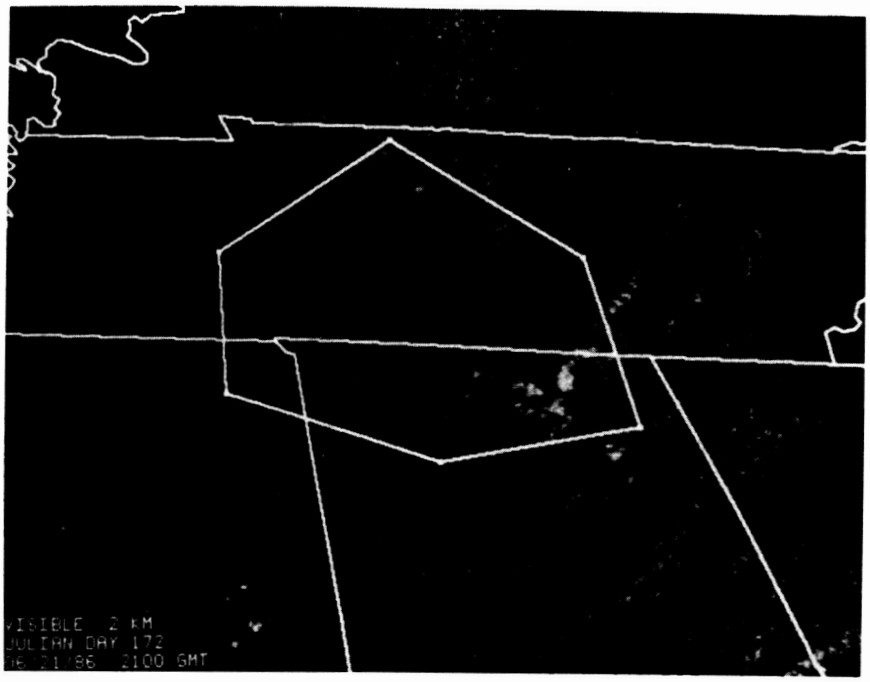


Fig. 3.2-20b. Visible 2 km GOES Central satellite image for 21 June 1986 2100 GMT

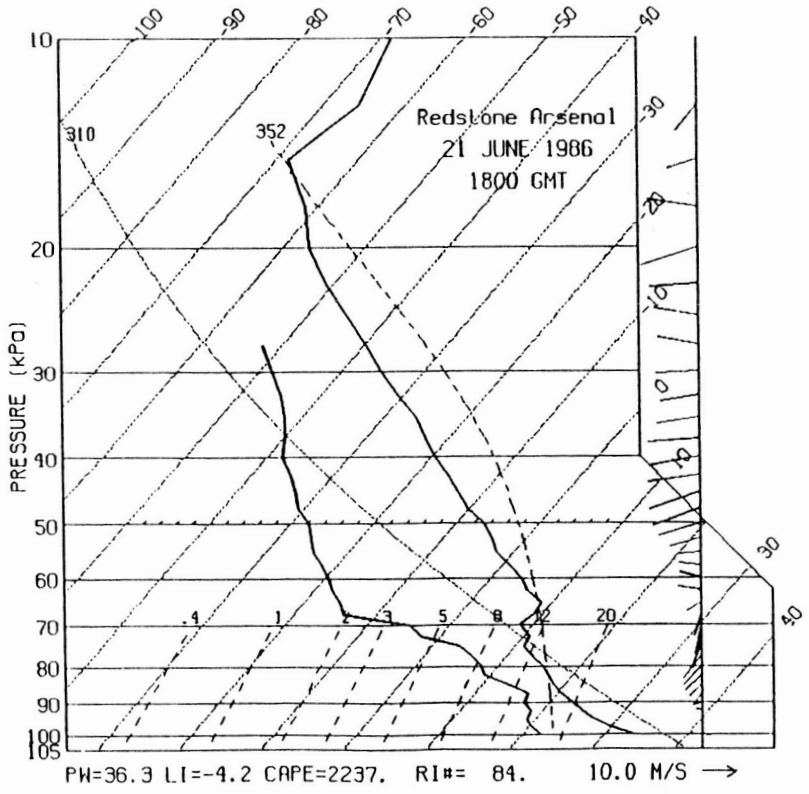


Fig. 3.2-20c. Redstone Arsenal, AL, rawinsonde sounding for 21 June 1986 1800 GMT

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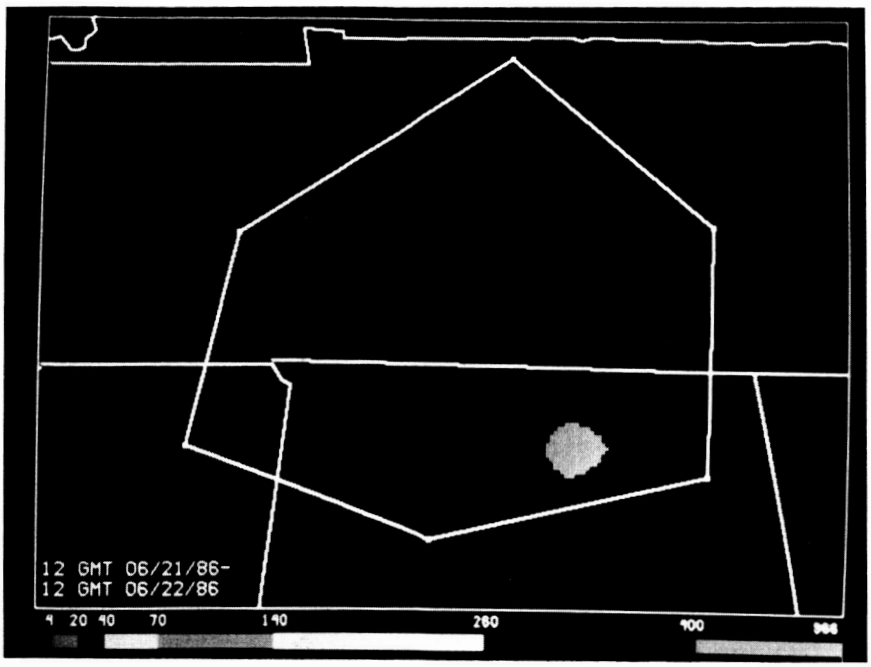


Fig. 3.2-20d. Twenty-four hour lightning strike density plot for 21-22 June 1986

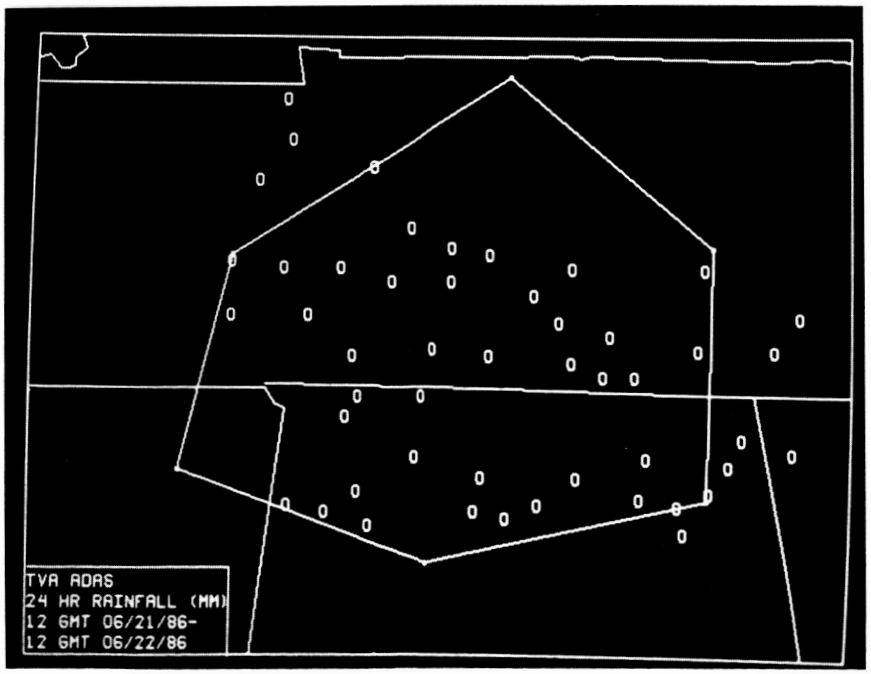


Fig. 3.2-20e. Twenty-four hour TVA ADAS rainfall totals (mm) for 21-22 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

22 June 1986

Synoptic Conditions

Large scale conditions observed today were similar to those seen yesterday. The upper level ridge stalled and remained over the western portion of the SPACE mesonet all day. The sounding showed similar wind and thermodynamic features, including an inversion near 700 mb and very weak flow at low levels. At the surface, a weakening anticyclone was located along the Atlantic Coast and another cold front was entering the Midwest. Over the SPACE mesonet, afternoon surface temperature and dewpoint values were 31-34 and 18-22 °C in the presence of variable flow.

Cloud/Precipitation Overview

First local cumulus formed around 1700 GMT and reached a cumulus mediocris stage by 1900 GMT. Some cumulus congestus actually penetrated the inversion but quickly dissipated due to entrainment. Visible satellite imagery indicated (a) that cumulus fields tended to form in clusters, and (b) that some isolated cumulonimbus formed over the SPACE network in Tennessee. Precipitation amounts from the scattered cumulonimbus were generally small.

Notes:

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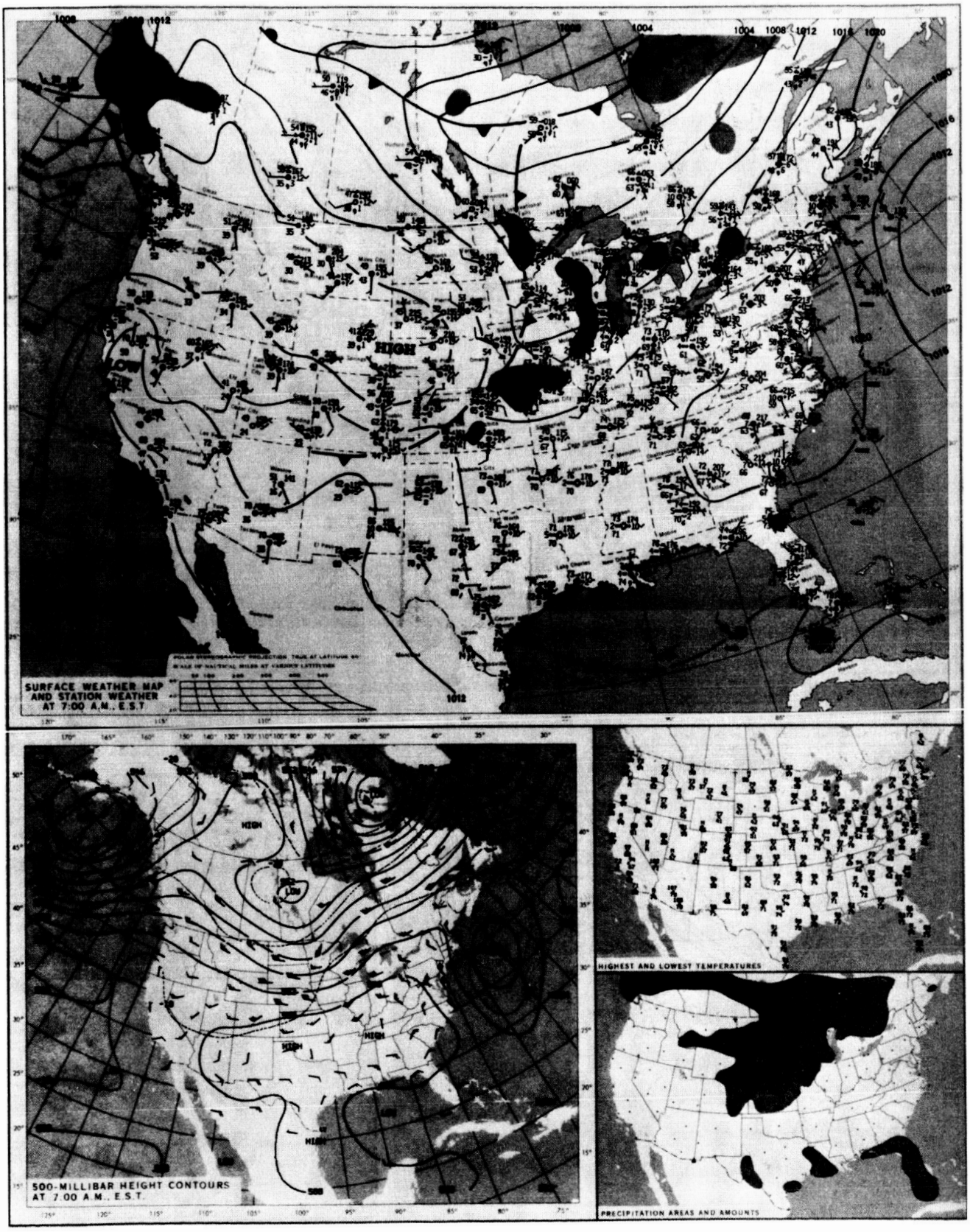


Fig. 3.2-21a. Synoptic weather conditions for 22 June 1986 1200 GMT

OPERATIONAL SUMMARY

22 June 1986

Rawinsonde Operations

The standard 1200 and 1800 GMT soundings were taken at RSA.

Radar Operations

No operations.

Satellite Operations

GOES RISOP was in effect all day. Therefore, VAS products are not available.

Aircraft Operations

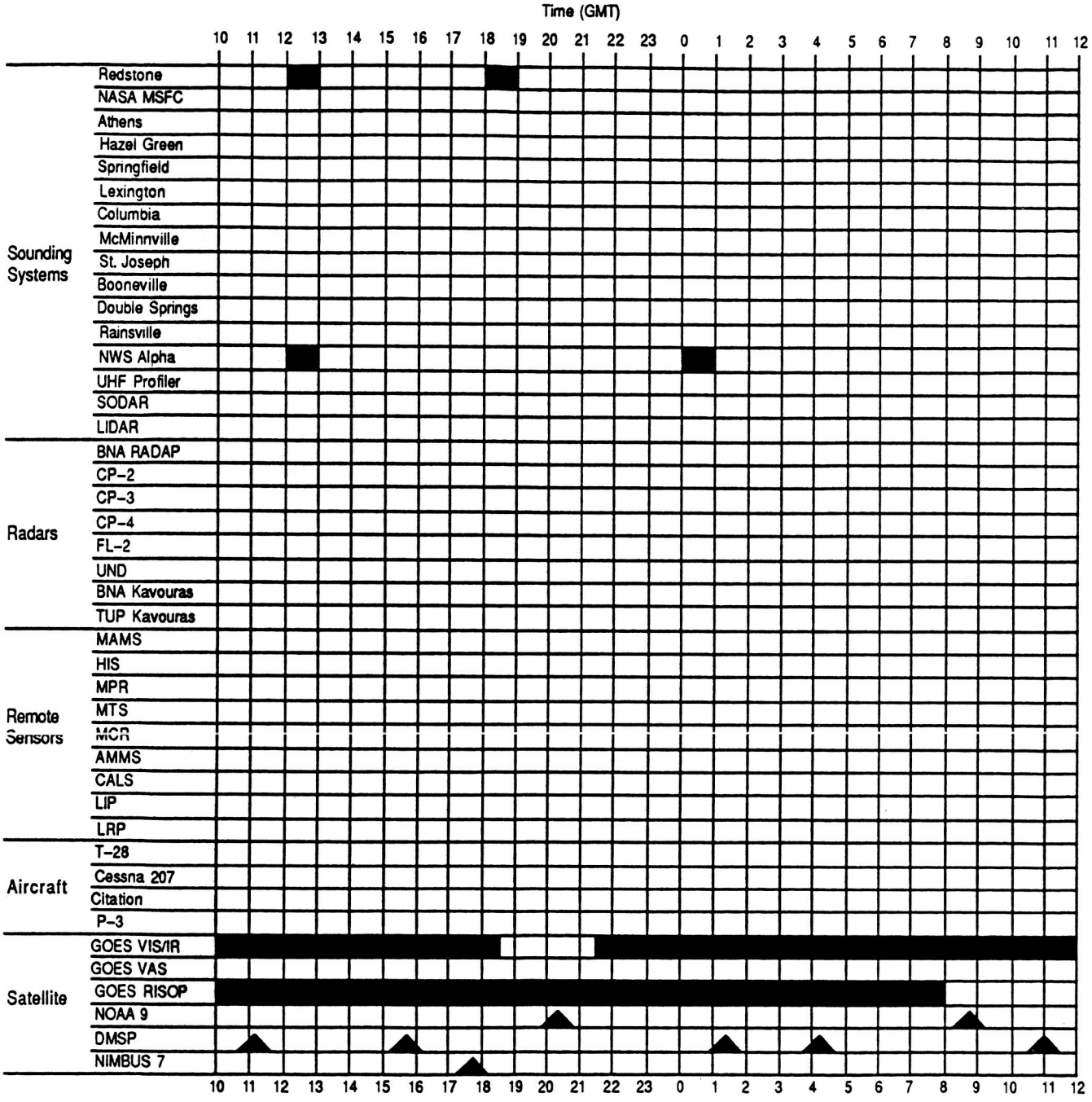
No operations.

Notes:

5-550-7-8 (21)

Day: SUNDAY
Date: 6/22/86
Julian Day: 173–174

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 3, 12, 16, 22, 40, & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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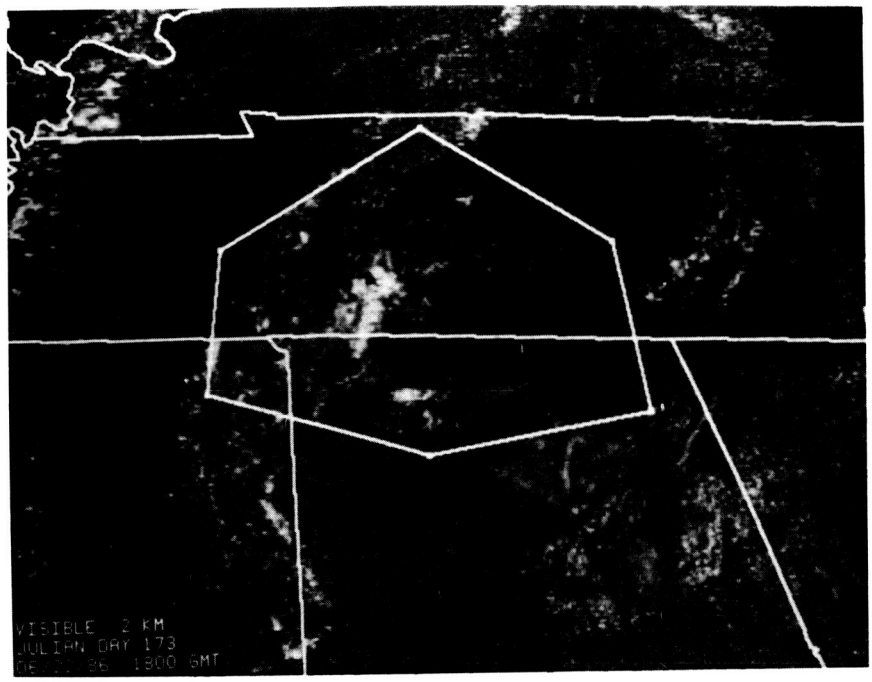


Fig. 3.2-21b. Visible 2 km GOES Central satellite image for 22 June 1986 1800 GMT

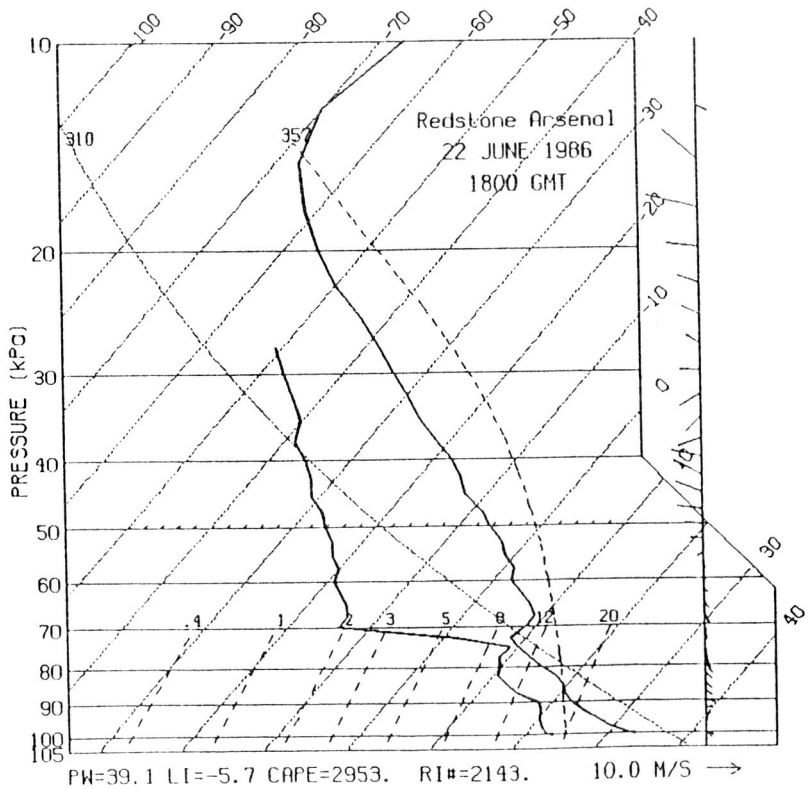


Fig. 3.2-21c. Redstone Arsenal, AL, rawinsonde sounding for 22 June 1986 1800 GMT

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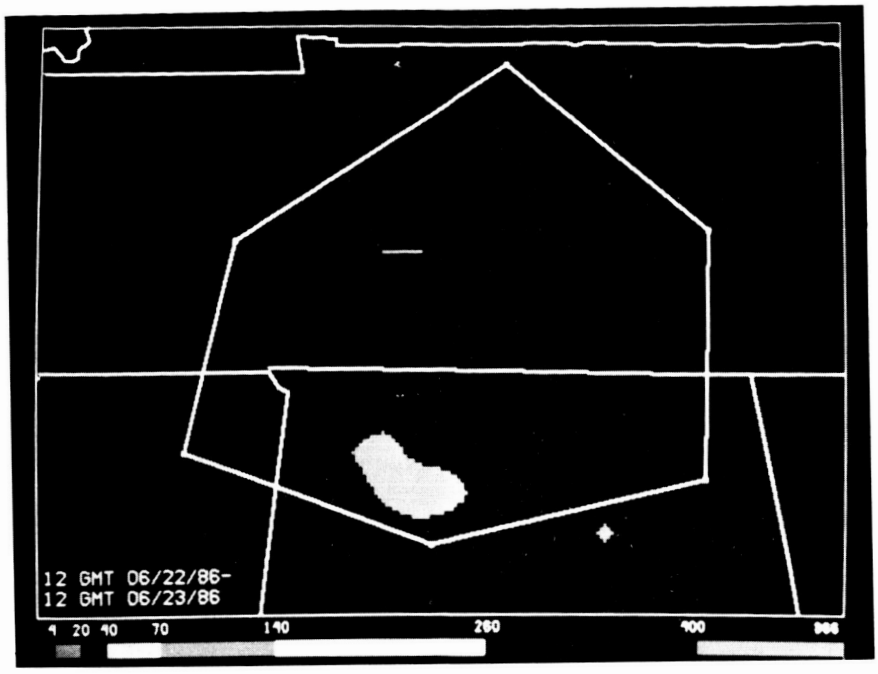


Fig. 3.2-21d. Twenty-four hour lightning strike density plot for 22-23 June 1986

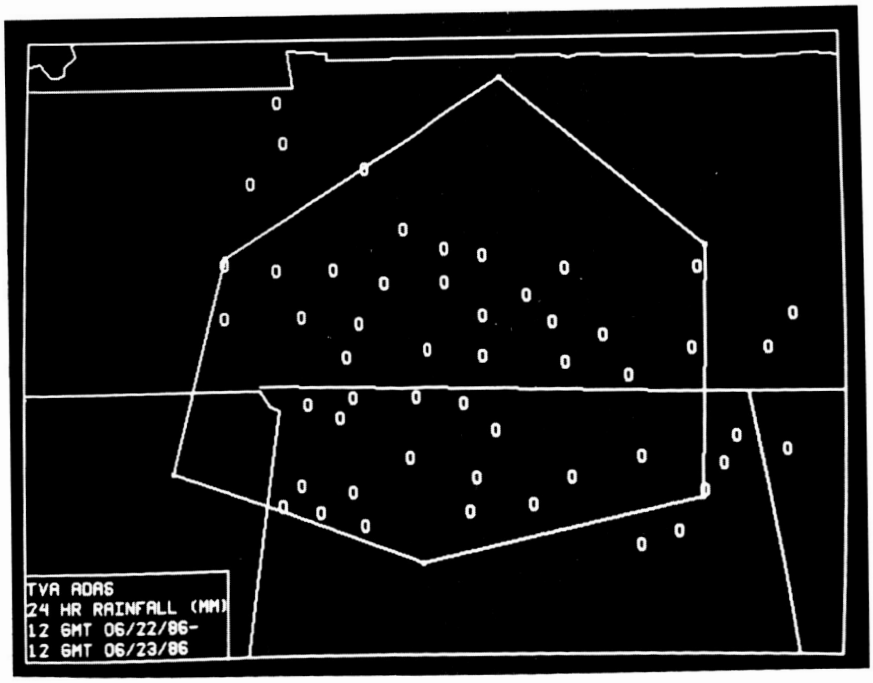


Fig. 3.2-21e. Twenty-four hour TVA ADAS rainfall totals (mm) for 22-23 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

23 June 1986

Synoptic Conditions

Uniform westerly flow was again established over the SPACE mesonet as the upper level ridge elongated in the north-south direction and dropped southward. Moisture content again dropped off near 700 mb, but the inversion at that level had weakened from that of the previous two days. Very little variation in total moisture was evident across the mesonet. By 0000 GMT a vigorous short wave trough located over Iowa was progressing towards the east-southeast. At the surface, a cold front continued to approach the experimental area from the northwest, ending up over southern Kentucky by evening. Afternoon values of temperature and dewpoint over the SPACE region were 31-34 °C and 19-23 °C in the presence of 2-5 m s^{-1} westerly flow.

Cloud/Precipitation Overview

Morning hours were generally clear. First clouds (cumulus humilis) formed around 1630 GMT. Most of the subsequent precipitating convection existed over Tennessee in three preferred areas and times. During the afternoon hours two active regions were observed over central Tennessee. The more active region was located over south-central Tennessee (near 035° at 90 km from CP-4). This area developed the first observable echo near 1820 GMT. Relatively intense convective activity then appeared to persist over this preferred genesis region from 1820 to 2340 GMT. Echo tops and peak intensity were 14 km and 60 dBZ, respectively. New cells persistently formed along the southwest flank and then drifted towards the northeast.

A second area of weaker convection was observed about 100 km west of the first. Longevity, cell intensity, and cloud tops were lower than in the initial system. A final area of intense convection in the form of an MCS affected the northern portion of the SPACE network during the evening hours. This system formed to the west during the afternoon and moved eastward, producing heavy rainfall and a well defined outflow.

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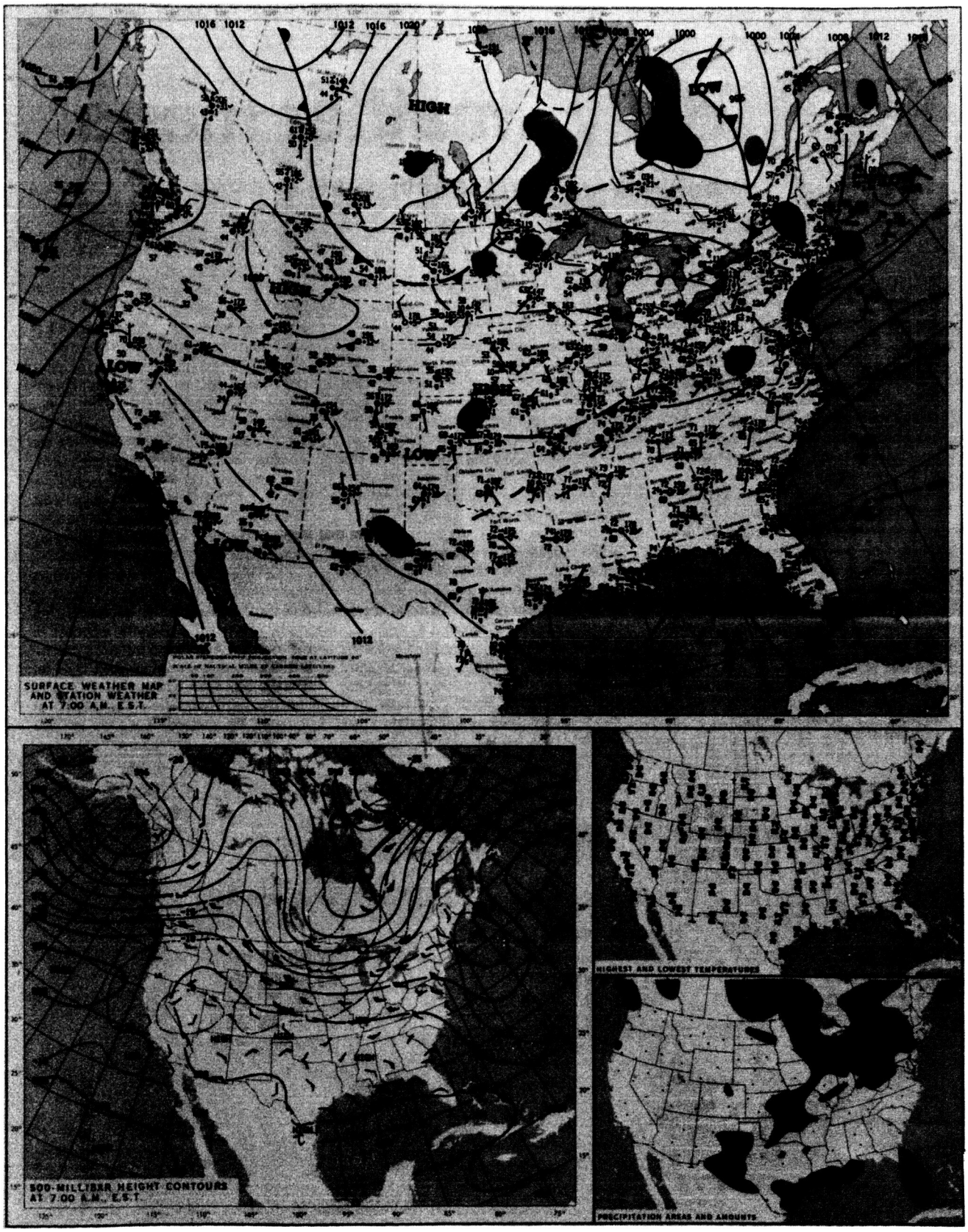


Fig. 3.2-22a. Synoptic weather conditions for 23 June 1986 1200 GMT

OPERATIONAL SUMMARY

23 June 1986

Rawinsonde Operations

A successful Meso-beta rawinsonde operation was carried out from 1800 to 0300 GMT. These soundings will overlap the aircraft flight times and should provide good *in situ* data in a largely clear environment.

Radar Operations

CP-2 and CP-4 acquired considerable single Doppler data on the two areas of convection located over south-central Tennessee. The persistent area of convection located north-northeast of the MIST/FLOWS network received the most attention, with both CP-2 and CP-4 conducting numerous RHI and PPI scans. CP-4 also provided 360° surveillance scans as usual.

Satellite Operations

GOES VAS products were acquired from 1400 to 2200 GMT and completely overlap in time the sounding portion of the ER-2 flight. RISOP was started after 0000 GMT 24 June, but this high resolution data is probably of little value for SPACE related work since convection was weakening by that time.

Aircraft Operations

The ER-2 conducted a combined sounding and storm mission from 2030 to 2300 GMT. Initially, a sounding flight consisting of two east-west legs was made over the southern portion of the SPACE mesonet. As a small cluster of thunderstorms formed over the central SPACE network, the ER-2 terminated the sounding mission and collected storm overflight data from 2130 to 2300 GMT. The T-28 provided support from ~2130 to ~2230 GMT, making three penetrations into the cloud system during this time interval.

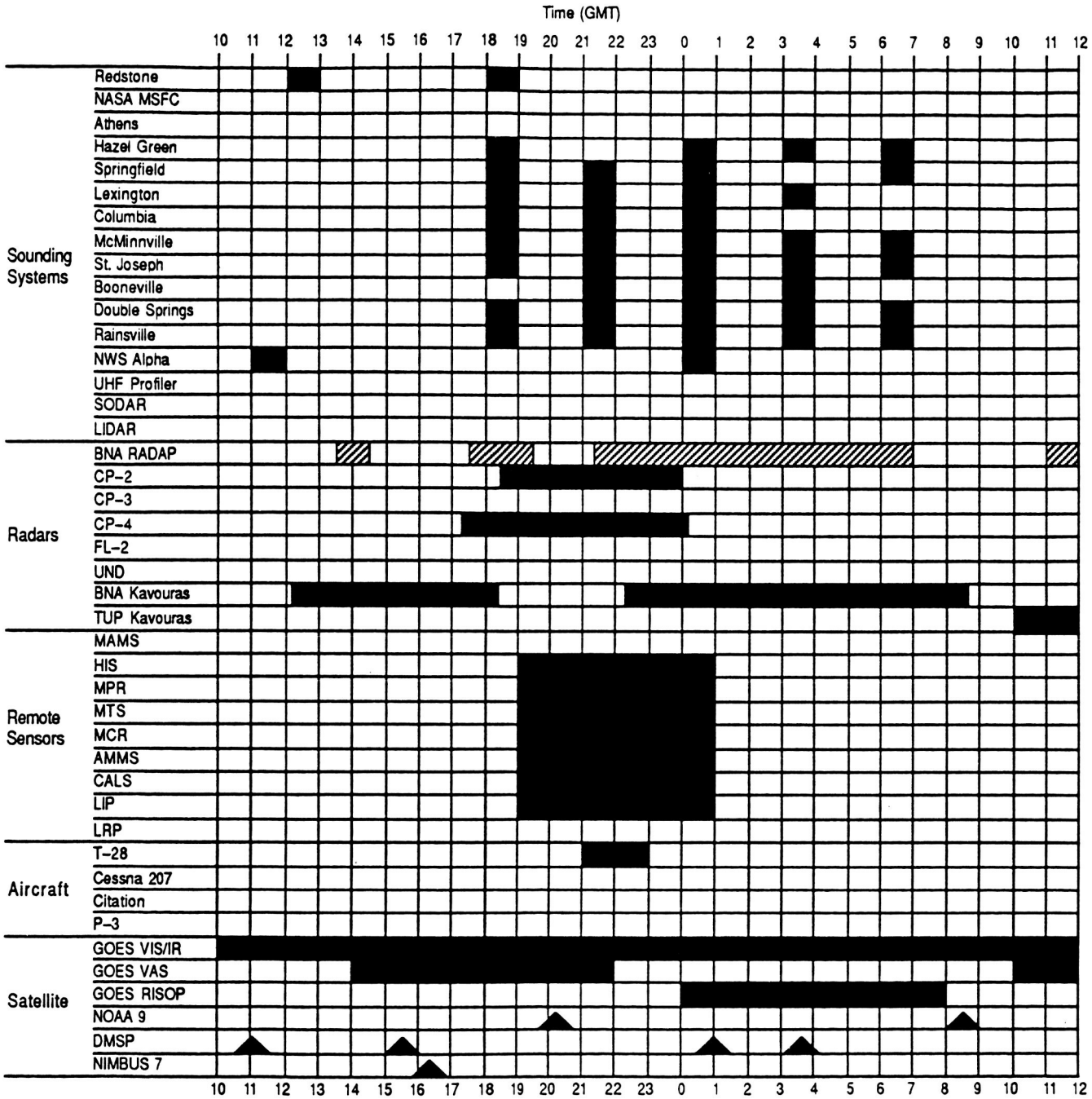
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5-550-7-8(22)

Day: MONDAY
Date: 6/23/86
Julian Day: 174–175

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 3, 12, 16, 40, 45 & 61
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

C-3

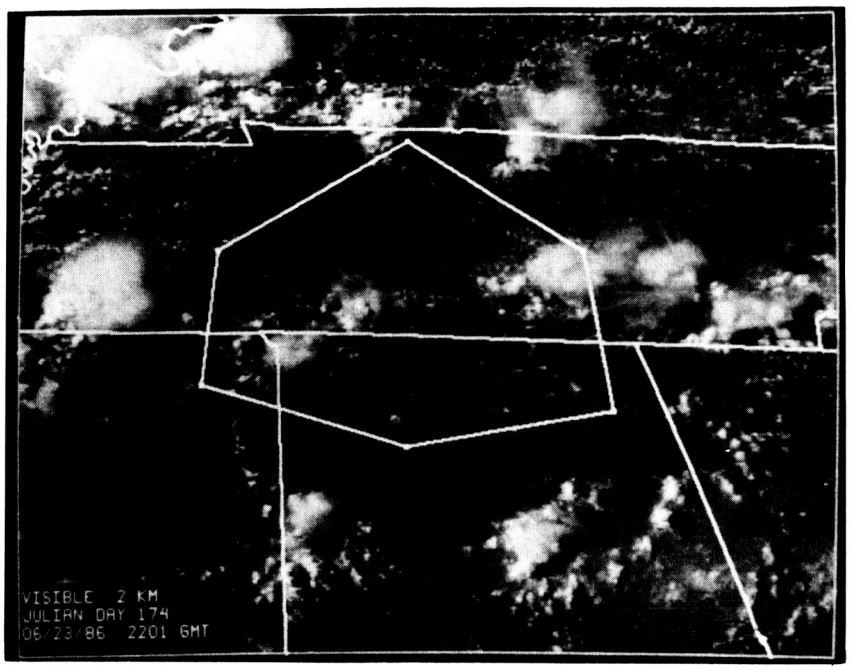


Fig. 3.2-22b. Visible 2 km GOES Central satellite image for 23 June 1986 2201 GMT

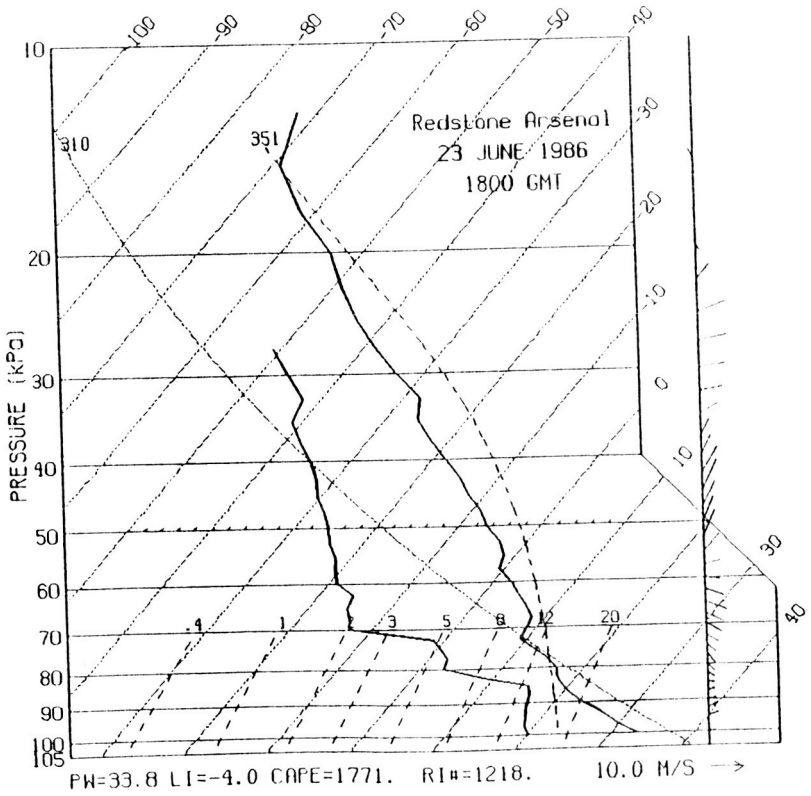


Fig. 3.2-22c. Redstone Arsenal, AL, rawinsonde sounding for 23 June 1986 1800 GMT

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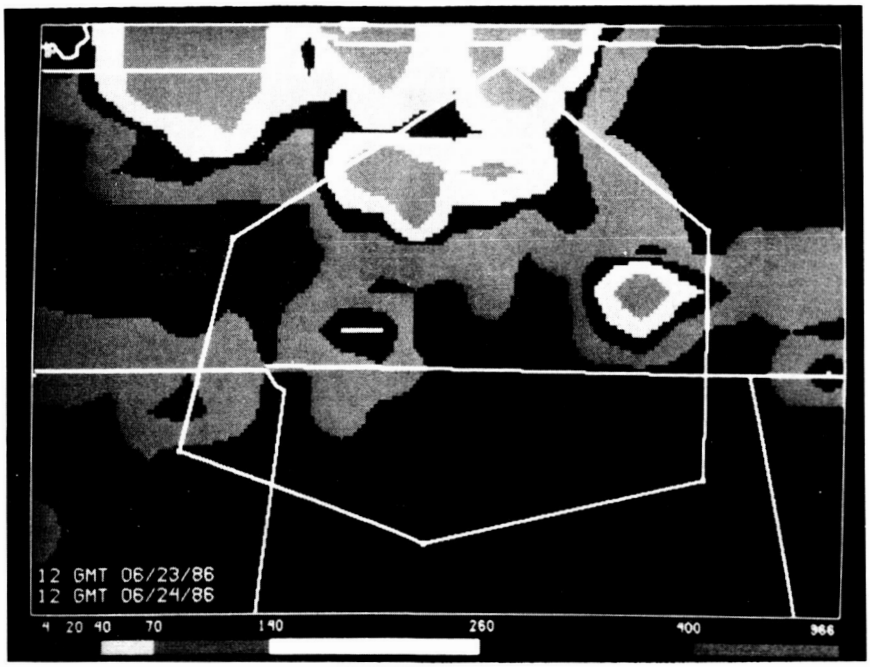


Fig. 3.2-22d. Twenty-four hour lightning strike density plot for 23-24 June 1986

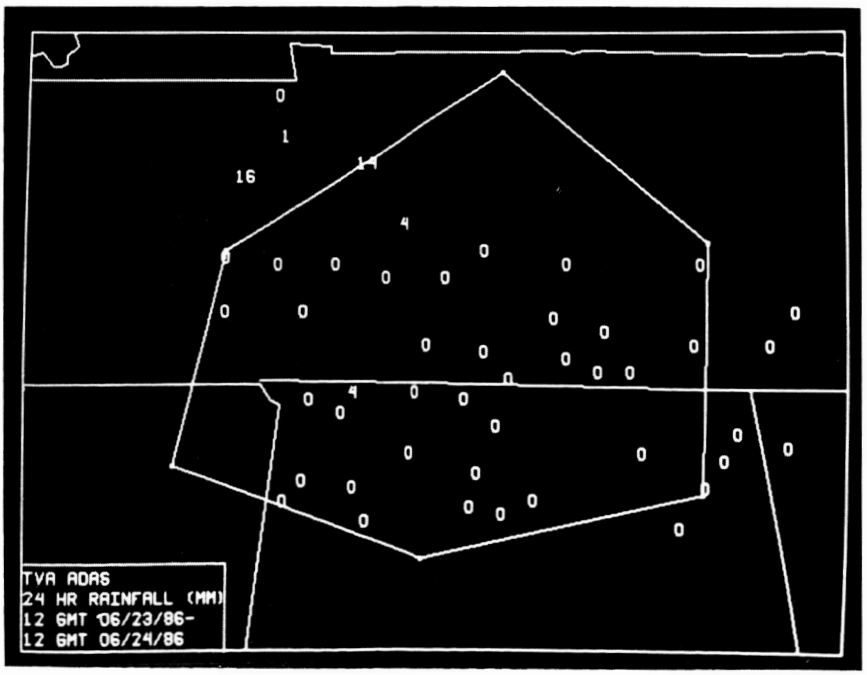


Fig. 3.2-22e. Twenty-four hour TVA ADAS rainfall totals (mm) for 23-24 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

24 June 1986

Synoptic Conditions

Synoptic conditions were more complicated than on previous days. Flow aloft continued to strengthen from a west to northwesterly direction. The southern portion of a short wave trough moved over the SPACE mesonet during the day. A surface trough appeared to form over the central SPACE mesonet in association with the upper level trough around 1200 GMT, and then moved southeastward from that point. This trough triggered early morning thunderstorms in the HSV area. During the afternoon hours, a cold front moved southward through the mesonet and triggered more intense thunderstorms over the southern mesonet during the afternoon hours. Early afternoon surface temperature and dewpoint values over the region were 30-33 °C and 19-22 °C, respectively. Total precipitable water remained much higher than average, and the air mass lifted index was in the -4 range.

Cloud/Precipitation Overview

Early thunderstorm activity formed locally by 1200 GMT in advance of a developing surface trough. By late morning, an east-west line of thunderstorms developed over the southern portion of the SPACE network and to the south. Secondary development to the north of the existing east-west line occurred discretely several times during the afternoon hours. Some of these storms were intense, producing locally heavy rainfall and strong wind gusts. Secondary convective development occurred near 2100 GMT ~30 km west of the MIST/FLOWS network. This area of convection began as isolated cells which eventually merged to produce a large line of storms oriented east-west. Cells within this line were initially intense, exhibiting >60 dBZ reflectivity factor, tops to 15 km, and relatively strong surface outflow winds. As the secondary line advanced to the south, general weakening took place, and the system dissipated by 0400 GMT. The convection over northern Alabama produced a large number of lightning flashes and local rainfall amounts in excess of 25 mm.

Notes:

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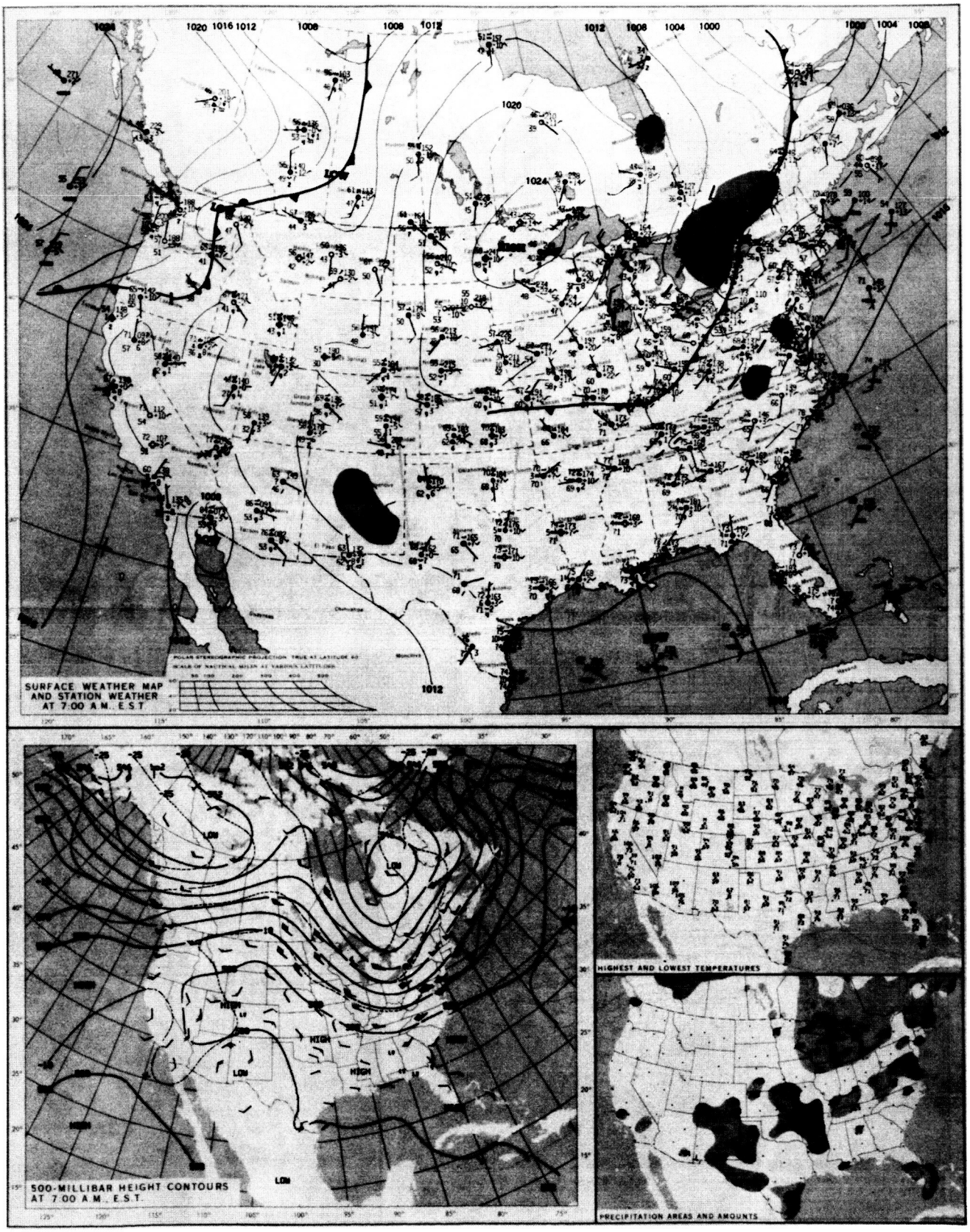


Fig. 3.2-23a. Synoptic weather conditions for 24 June 1986 1200 GMT

OPERATIONAL SUMMARY

24 June 1986

Rawinsonde Operations

A full Meso-alpha and Meso-beta operation was carried out from 1500 to 0300 GMT. Of the 45 total releases over the SPACE mesonet, only five appear to have been unsuccessful, but four of these were unfortunately over the southern network at 0300 GMT in the presence of the weakening east-west convective line. The special 3-h NWS soundings taken at those sites surrounding the SPACE network should provide information on the changing synoptic scale environment associated with the short wave trough and cold front.

Radar Operations

The Doppler radars, except for FL-2, captured only the final stages of the morning thunderstorm activity. However, the afternoon activity was well documented in the form of surveillance and sectorized PPI scans. A very good multiple Doppler radar study coordinated with U-2 and T-28 aircraft was accomplished on an intense multicell complex located 30-50 km west of CP-4. Afterwards, dual Doppler scans were conducted on less intense convection located close to CP-4. Also, full volume sector and surveillance scans were later made on the convective line located to the south.

Satellite Operations

Normal GOES satellite operations were in effect, with essentially all VAS products generated at UW from 1000 to 2130 GMT.

Aircraft Operations

The ER-2 conducted a lightning related storm mission over northern Alabama from ~2000 to 2230 GMT. About six passes were conducted over intense convection located ~40 km west of the Doppler radar network. The Doppler radars provided excellent single and multiple Doppler radar coverage during these overflights.

The T-28 made 3 penetrations between 2130 and 2230 GMT in the general vicinity of the ER-2 overflights. However, convective cores were considered too intense for safe penetration, and passes were generally made adjacent to and east (downshear) of the high reflectivity zones.

Notes:

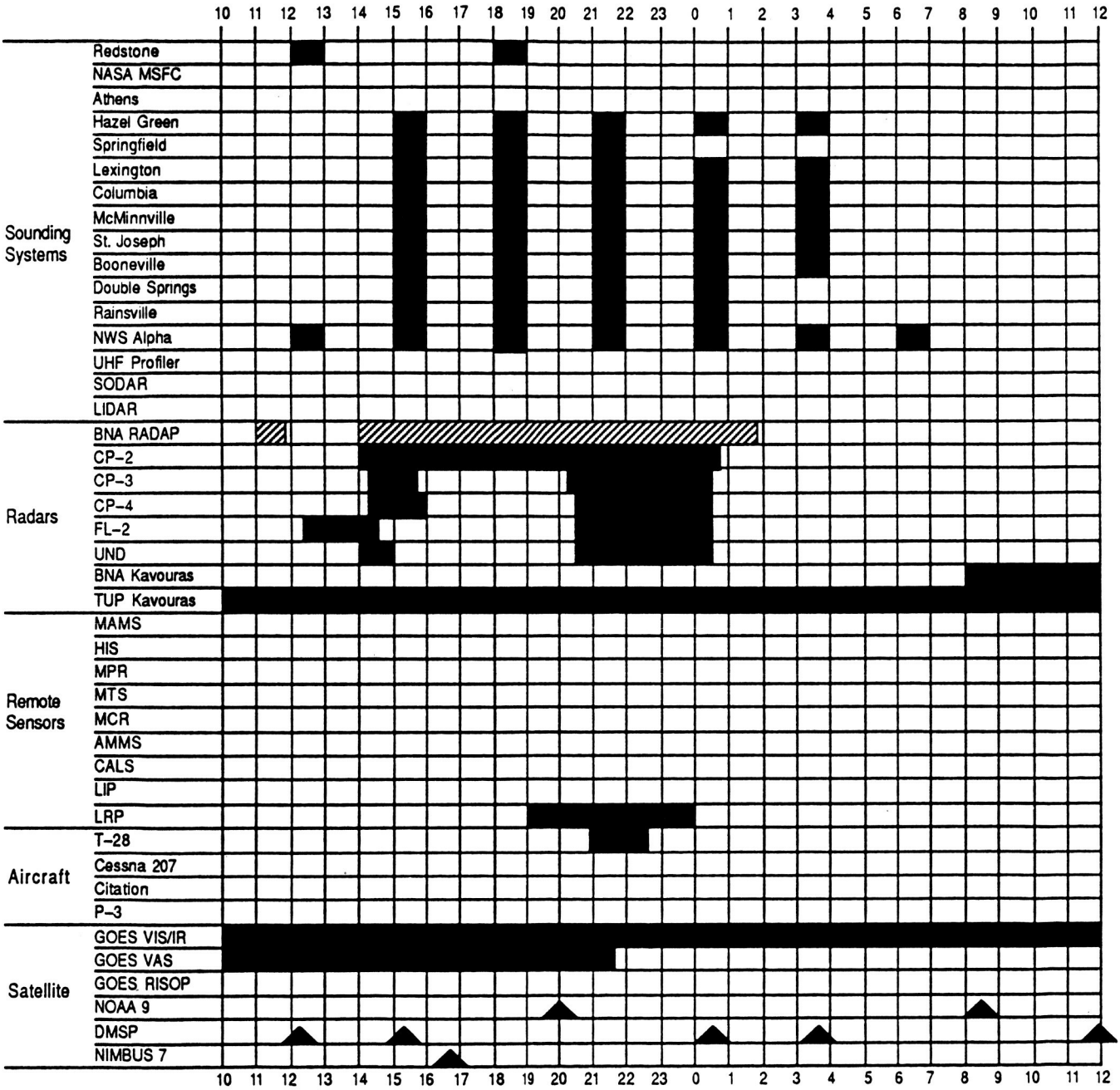
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5-550-7-8-(23)

Day: TUESDAY
Date: 6/24/86
Julian Day: 175–176

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 3, 12, 16, 22 & 45
	LLP	OPERATIONAL
	Mobile Lab	2014–2311 GMT; BALLOON LAUNCH

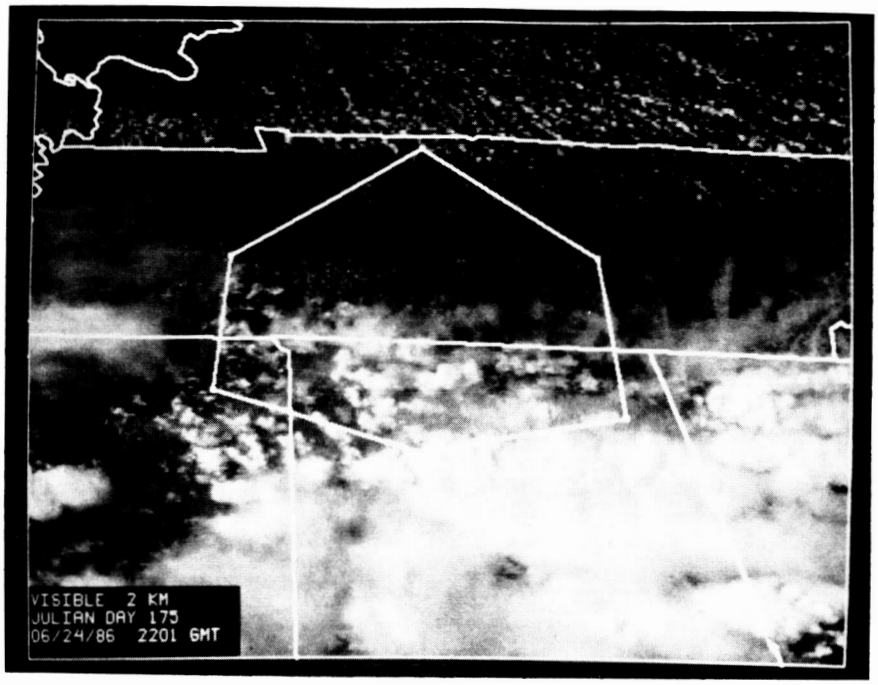


Fig. 3.2-23b. Visible 2 km GOES Central satellite image for 24 June 1986 2201 GMT

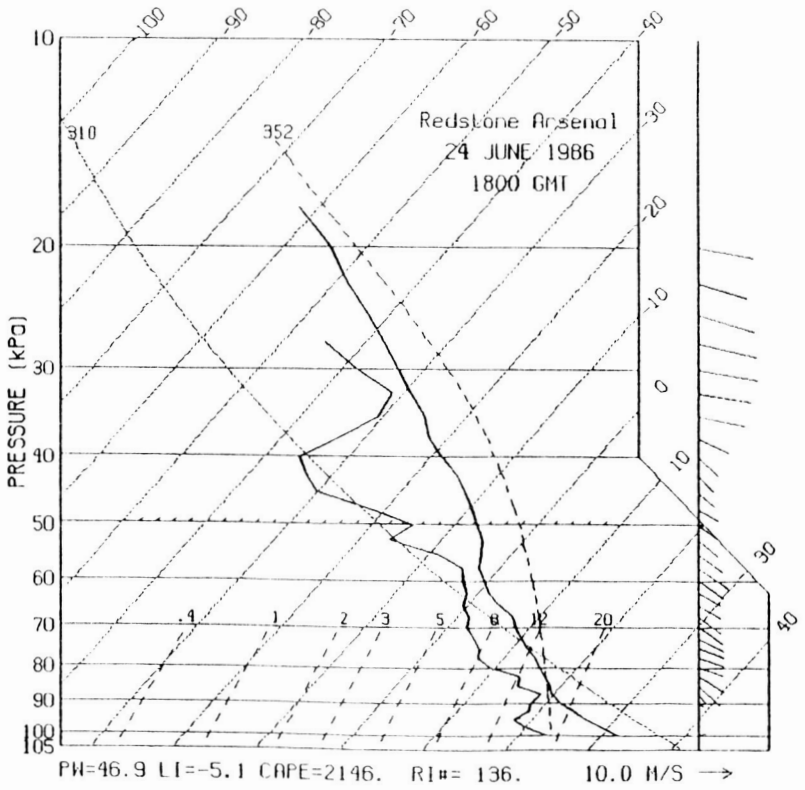


Fig. 3.2-23c. Redstone Arsenal, AL, rawinsonde sounding for 24 June 1986 1800 GMT

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Fig. 3.2-23d. Twenty-four hour lightning strike density plot for 24-25 June 1986

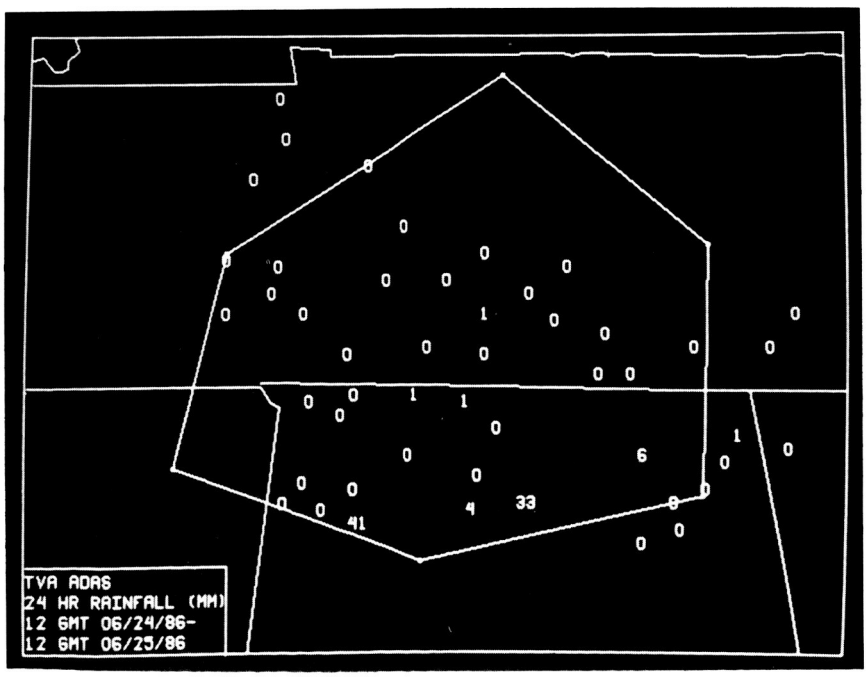


Fig. 3.2-23e. Twenty-four hour TVA ADAS rainfall totals (mm) for 24-25 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

25 June 1986

Synoptic Conditions

The atmosphere over the SPACE mesonet showed considerable stabilization from 800 to 550 mb in the post cold frontal air mass. Drying was significant over the northern portion of the mesonet, and this produced a large north-south gradient in total precipitable water and moist static stability by 0000 GMT 26 June. Winds aloft decreased in strength (5-10 m s^{-1}) from the west to northwest as a subtropical ridge pushed northward. At the surface, the front which pushed through the mesonet yesterday turned stationary over central Alabama, and the surface trough was located along the Gulf Coast. Over the Gulf, Hurricane Bonnie had appeared by 1200 GMT and would affect the SPACE region on 28 June. Afternoon surface temperature and dewpoint values over the SPACE network varied from 29 and 17 °C over the northern mesonet to 32 and 23 °C over the southern mesonet. Surface flow was north to northwesterly at 3-4 m s^{-1}.

Cloud/Precipitation Overview

Stable conditions prevented development of deep precipitating convection over the SPACE mesonet. Scattered cumulus mediocris and a few limited cumulus congestus developed by late morning but dissipated by midafternoon. No precipitation was recorded over the beta network. Widely scattered thunderstorm activity was located along a 200 - 300 km wide band from central Mississippi to southern Georgia.

Notes:

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25 June 1986

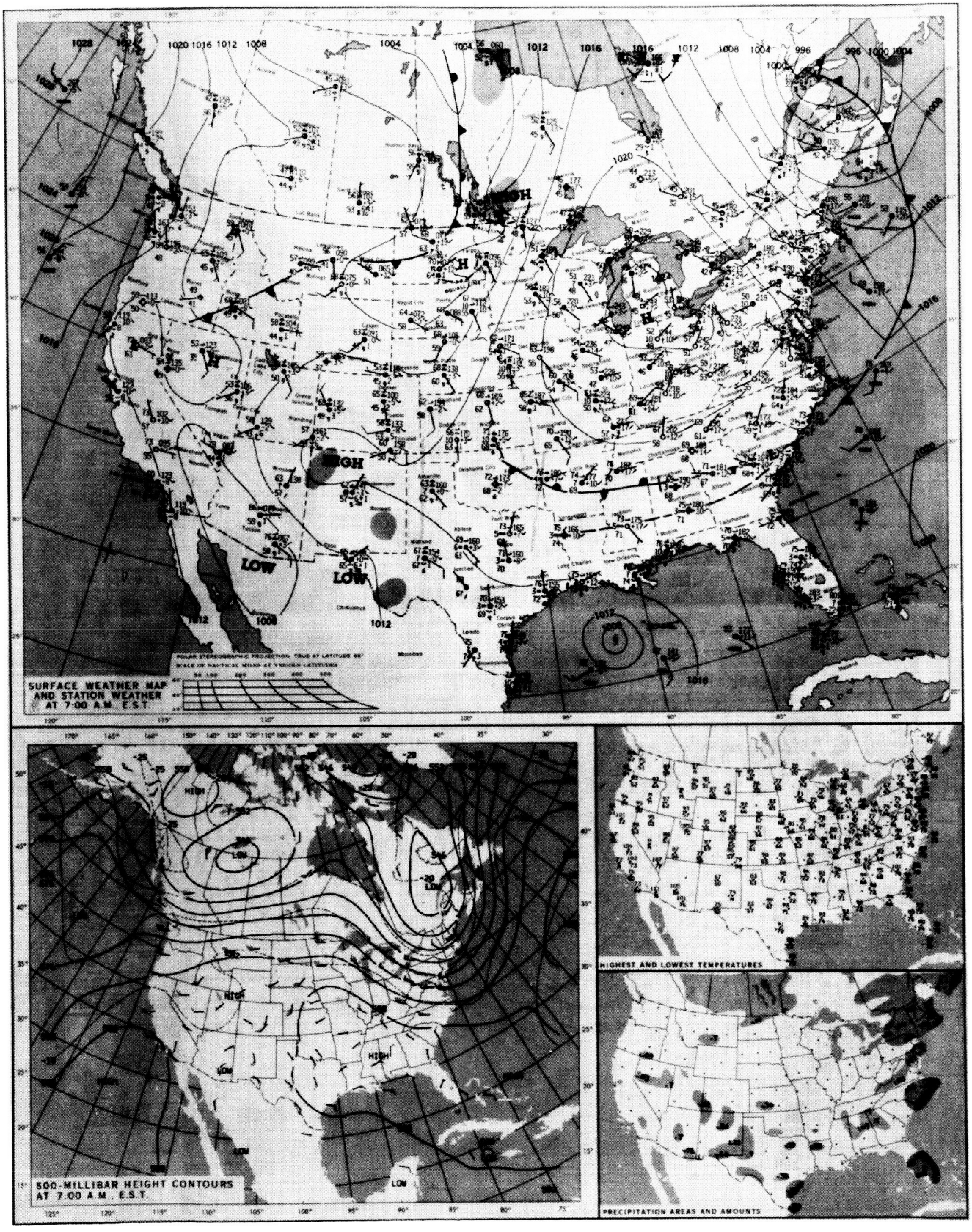


Fig. 3.2-24a. Synoptic weather conditions for 25 June 1986 1200 GMT

OPERATIONAL SUMMARY

25 June 1986

Rawinsonde Operations

The usual 1200 and 1800 GMT launches were made at RSA.

Radar Operations

Only CP-2 acquired limited data for a short time period.

Satellite Operations

GOES operations were normal. VAS products were not retrieved due to problems at Wallops Island, Va.

Notes:

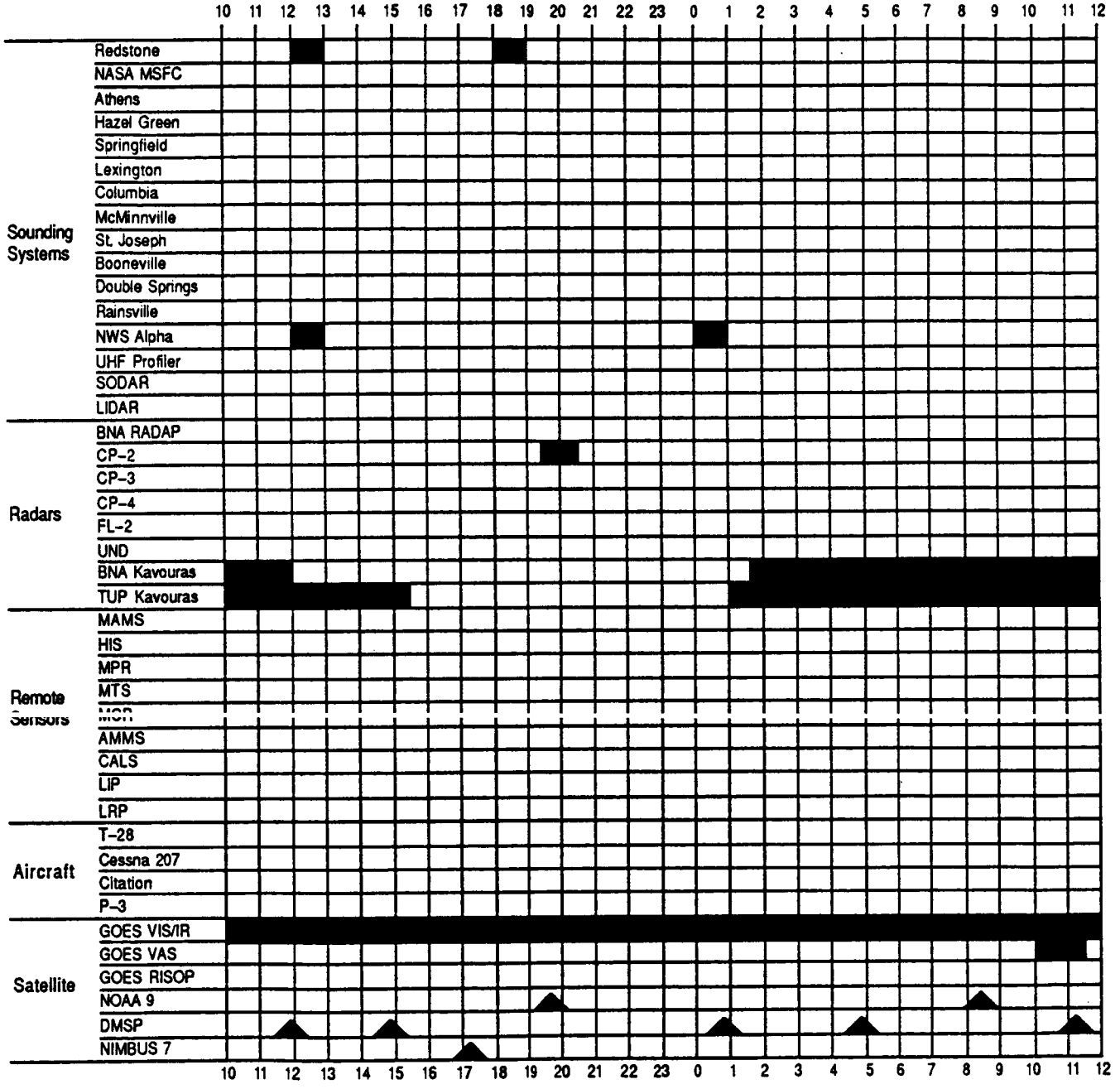
5-550-7-8(24)

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Day: WEDNESDAY
Date: 6/25/86
Julian Day: 176–177

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 3, 12, 16, 23 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL



Fig. 3.2-24b. Visible 2 km GOES Central satellite image for 25 June 1986 2000 GMT

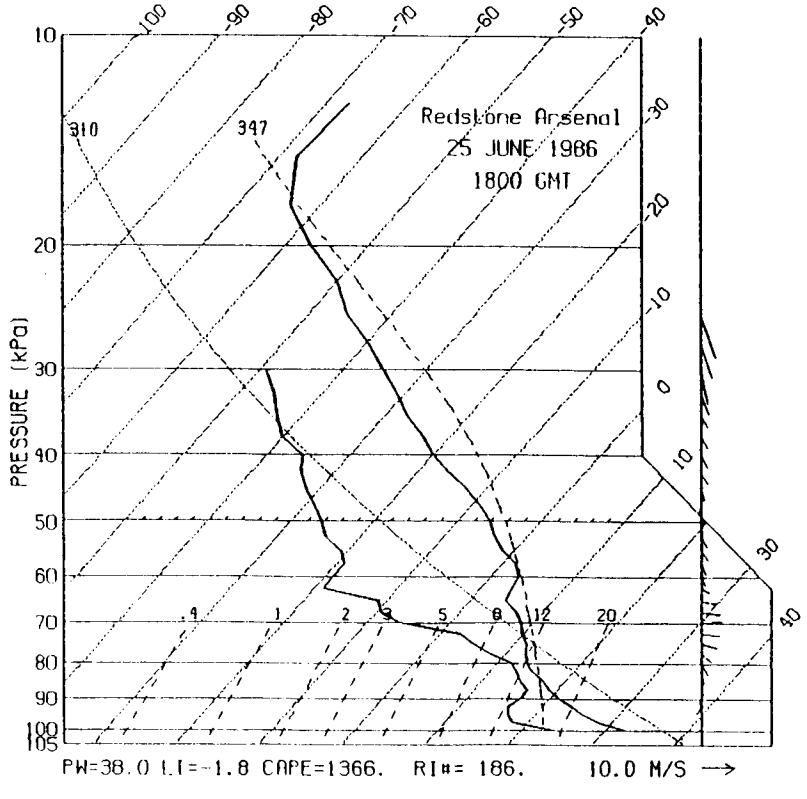


Fig. 3.2-24c. Redstone Arsenal, AL, rawinsonde sounding for 25 June 1986 1800 GMT

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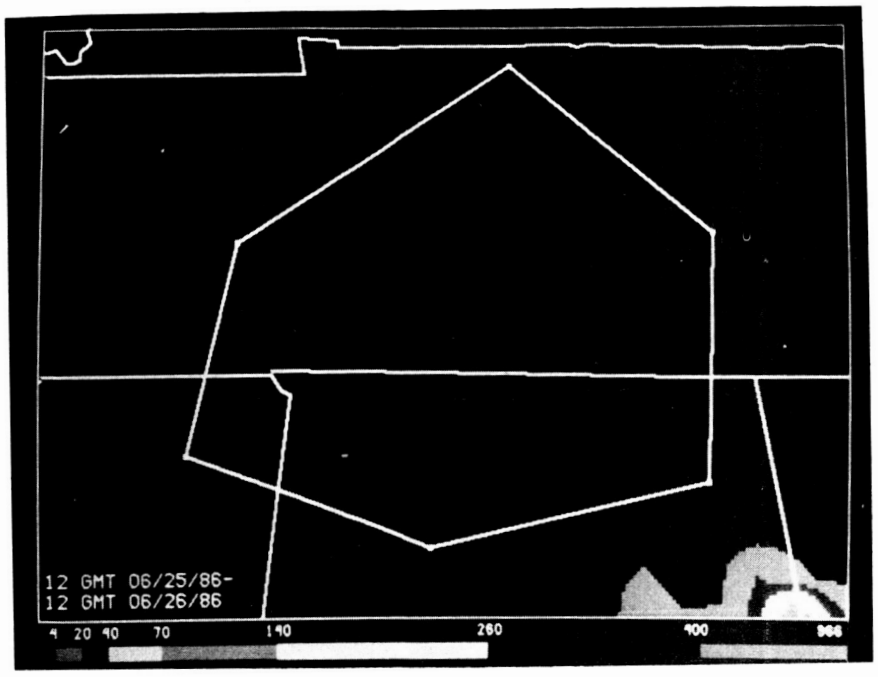


Fig. 3.2-24d. Twenty-four hour lightning strike density plot for 25-26 June 1986

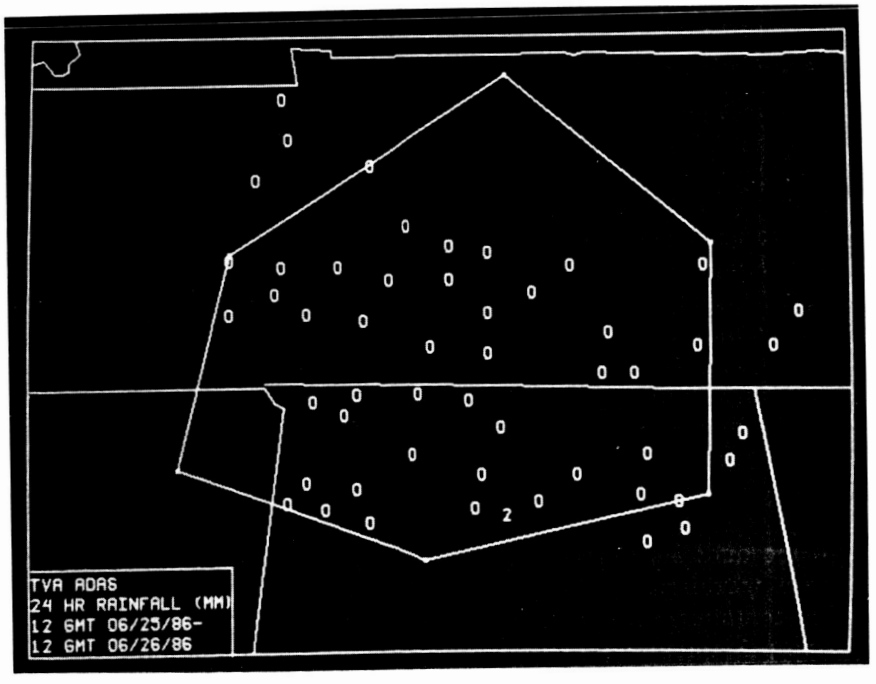


Fig. 3.2-24e. Twenty-four hour TVA ADAS rainfall totals (mm) for 25-26 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

26 June 1986

Synoptic Conditions

The broad subtropical ridge persisted just to the southeast of the SPACE mesonet during the day. Upper level flow remained light and westerly at lower to middle levels. At lower levels, the ridge axis was located just to the east, allowing low level moisture advection by westerly flow during the day. Over BNA, precipitable water values increased from 14 mm at 1200 GMT to 33 mm at 0000 GMT. Moist static instability values were consequently greater over the entire SPACE network. The old stationary frontal zone present over Alabama yesterday lost its identity by evening today. Afternoon temperature and dewpoint values over the network varied from 29 and 15 °C over the northern SPACE mesonet to 32 and 21 °C over the southwestern mesonet.

Cloud/Precipitation Overview

Convective activity reappeared over the SPACE mesonet as greater low level moisture returned in westerly flow. Cumulus clouds formed quickly (cumulus mediocris by 1500 GMT) during the morning, then exhibited a lull in further growth for 1-2 h around local noon. By midafternoon further vertical growth was noted. A small cluster of moderately intense precipitating convection was observed just southwest of the Doppler radar network during the late afternoon to early evening hours. One cell moved into range of multiple Doppler coverage just southwest of the MIST/FLOWS network. Satellite imagery indicated that this activity developed from an enhanced cloud field having its major axis aligned northwest to southeast. Some of these cells produced low level outflow magnitudes and divergences of moderate strength (FL-2 reported low level radial velocity differentials of 12 - 18 m s^{-1}). Outflows from individual cells later merged to form a larger scale weak gust front which eventually moved into the MIST/FLOWS network. The drier northern portion of the beta network remained nearly cloud free throughout the afternoon hours.

Notes:

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26 June 1986

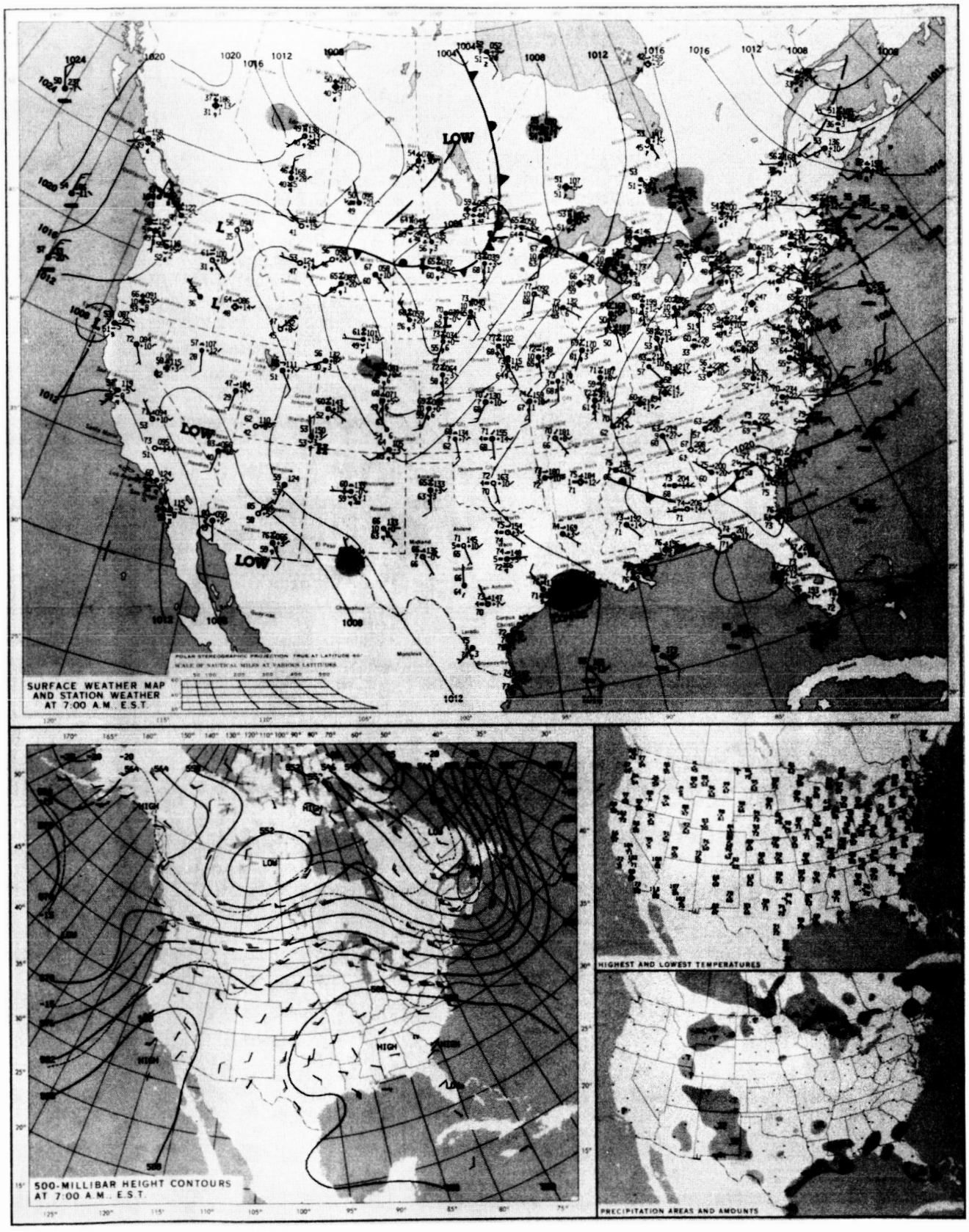


Fig. 3.2-25a. Synoptic weather conditions for 26 June 1986 1200 GMT

OPERATIONAL SUMMARY

26 June 1986

Rawinsonde Operations

A limited Meso-beta rawinsonde operation was conducted at 1800 and 2100 GMT by four stations arranged in a north-south line through the center of the beta network. This operation was in support of the U-2 flight and should show a north-south gradient in moisture over the SPACE mesonet.

Radar Operations

CP-4 conducted surveillance scans as usual. Convective clouds which formed 30-50 km southwest of the MIST/FLOWS network were closely examined by all Doppler radars from ~2300 to ~0200 GMT. Some dual Doppler scans were collected on targets at about 30-40 km range.

Satellite Operations

GOES VAS products were not available after 1300 GMT due to problems at Wallops Island, Va. RISOP was started at 1830 GMT and should provide good data for the cloud initiation process that took place over the southwestern Meso-beta network from 2000 to 0000 GMT.

Aircraft Operations

The ER-2 (MAMS, HIS) conducted a solo sounding mission from 1500 to 1815 GMT. The flight consisted of a repeated double leg loop (two superimposed north-south legs) over the central SPACE mesonet. Two and one-half loops were completed along this circuit, which passed over an apparent cloud discontinuity appearing in visible satellite imagery. Thunderstorms formed about 6 h later along this convective cloud line.

The T-28 conducted an independent cloud investigation mission from 2220 to 0000 GMT. Six penetrations were accomplished between 2230 and 2340 GMT over the region 40-50 km southwest of CP-2, within clouds having maximum reflectivity factor near 50 dBZ. Penetrations were made over the life cycle of one cloud.

The Citation conducted its first flight of the experiment from 2030 to 2230 GMT. Several low level penetrations were made through the outflow of one cell, and boxes were later flown around the same cell.

Notes:

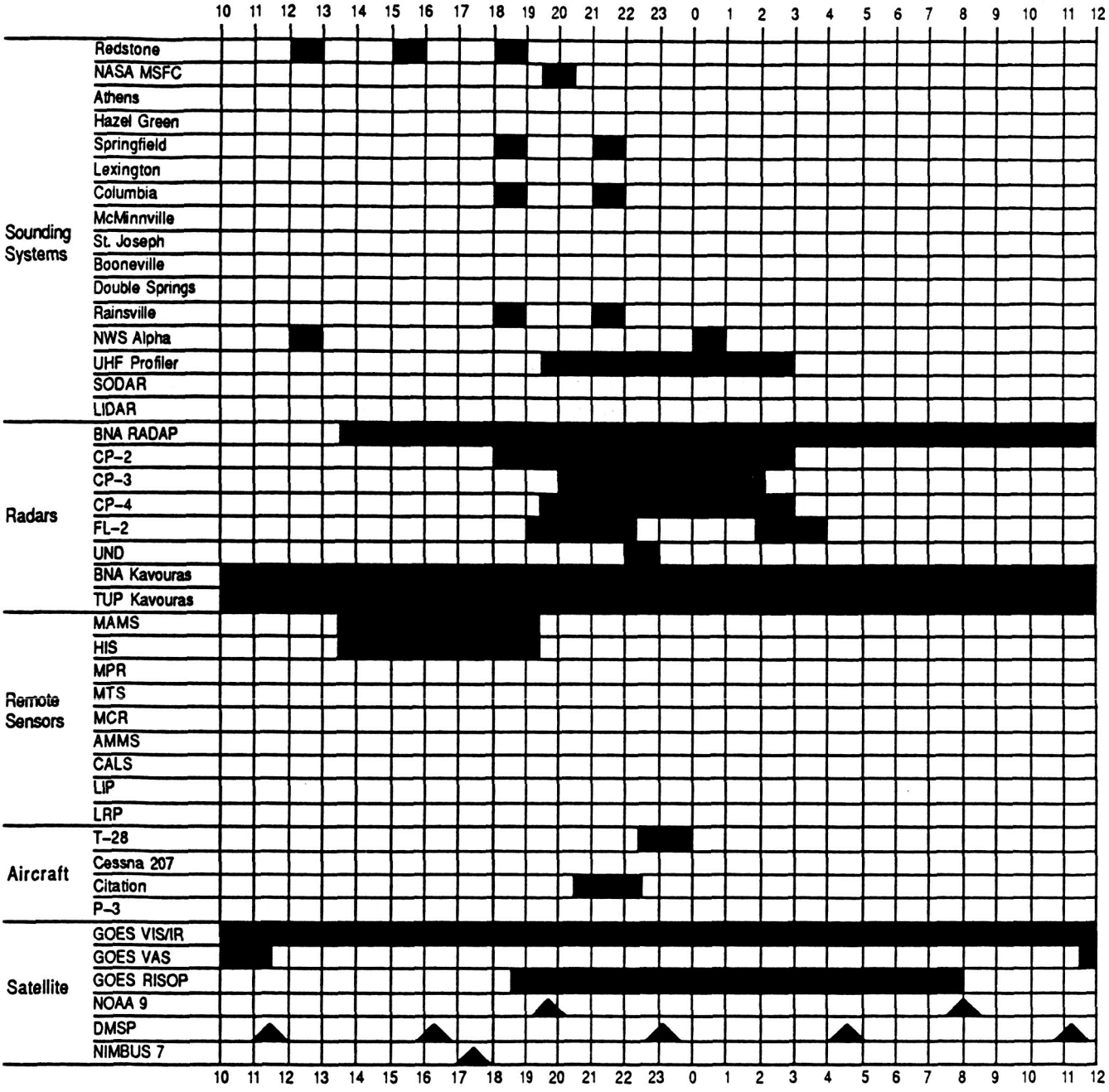
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5-550-7-8(25)

Day: THURSDAY
Date: 6/26/86
Julian Day: 177–178

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 12, 16 & 23
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

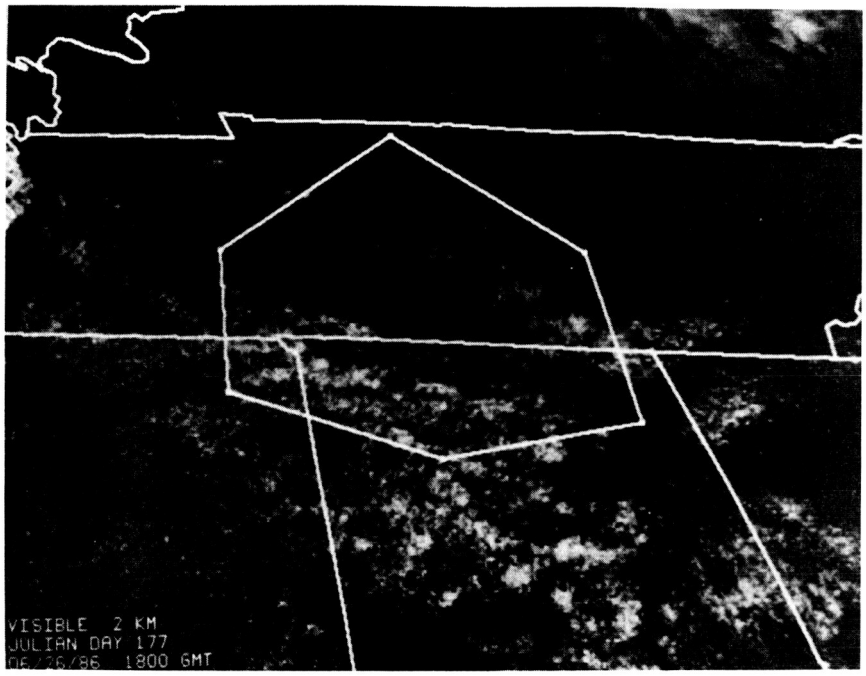


Fig. 3.2-25b. Visible 2 km GOES Central satellite image for 26 June 1986 1800 GMT

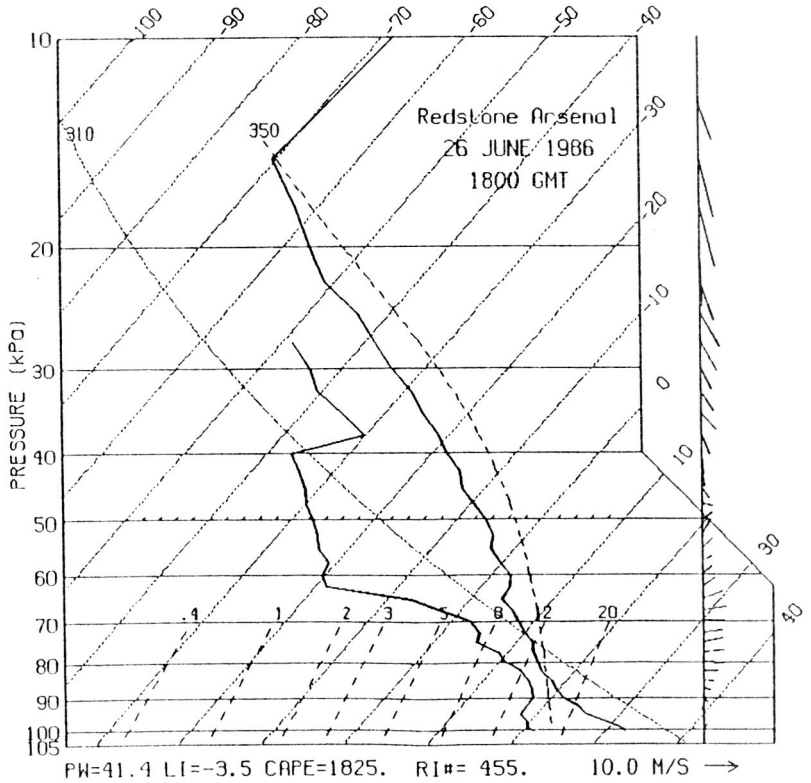


Fig. 3.2-25c. Redstone Arsenal, AL, rawinsonde sounding for 26 June 1986 1800 GMT

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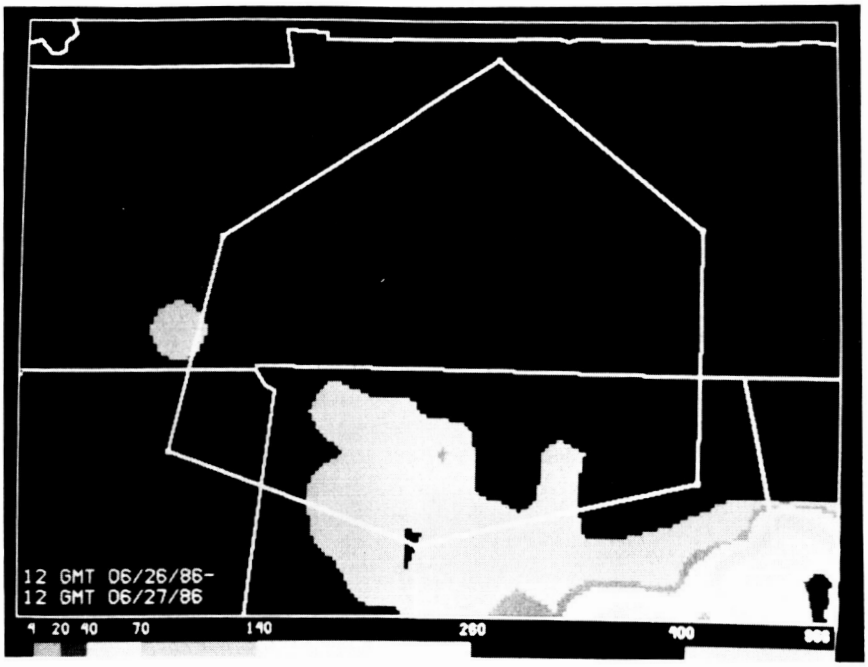


Fig. 3.2-25d. Twenty-four hour lightning strike density plot for 26-27 June 1986

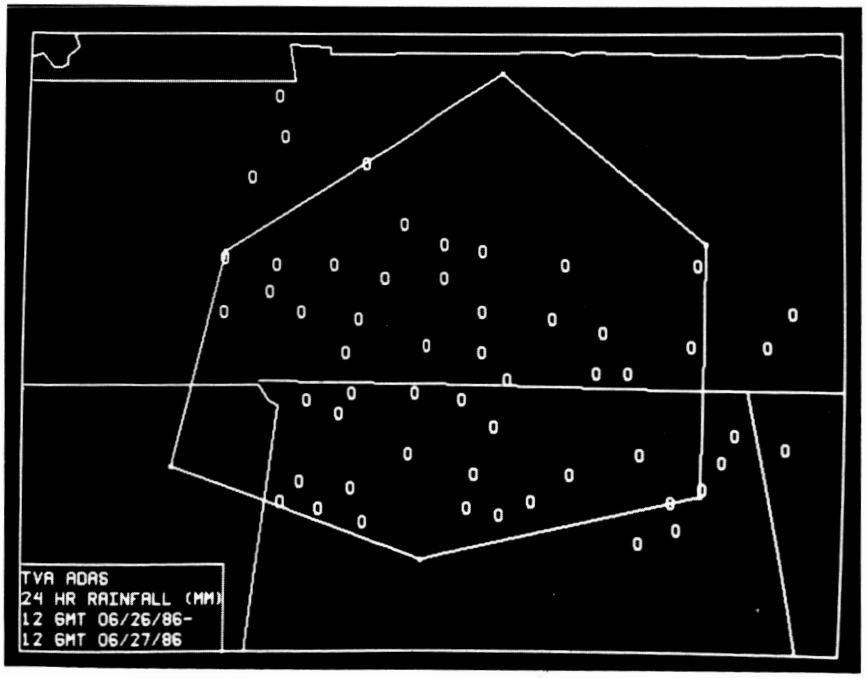


Fig. 3.2-25e. Twenty-four hour TVA ADAS rainfall totals (mm) for 26-27 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

27 June 1986

Synoptic Conditions

The broad and diffuse subtropical ridge remained to the south and east of the SPACE mesonet. Winds aloft remained light and generally westerly from low to middle levels, veering to northeasterly at upper levels. Total precipitable water was uniformly high over the region, and moist static instability remained significant. The only prominent surface feature over the entire Southeast was the remnants of Hurricane Bonnie which appeared as a cyclonic circulation at low levels, located over Arkansas at 1800 GMT. Afternoon surface temperature and dewpoint values over the SPACE mesonet were 31-34 °C and 20-22 °C in the presence of southwesterly flow of ~5 m s^{-1}.

Cloud/Precipitation Overview

Cumulus congestus clouds and deep convection were most prevalent from the MIST/FLOWS network and to the east throughout the day. Precipitating convection was generally not too intense, although a couple of cloud systems did manage to produce a moderate number of cloud-to-ground lightning strikes over the eastern SPACE mesonet. Typical echoes were 2-5 km in diameter, reached heights of 7-10 km, exhibited little radial velocity structure, but attained core reflectivity factor in excess of 55 dBZ. Low level divergent outflow winds were not apparent in any cloud system. Precipitation amounts over the beta network were generally isolated and small.

Notes:

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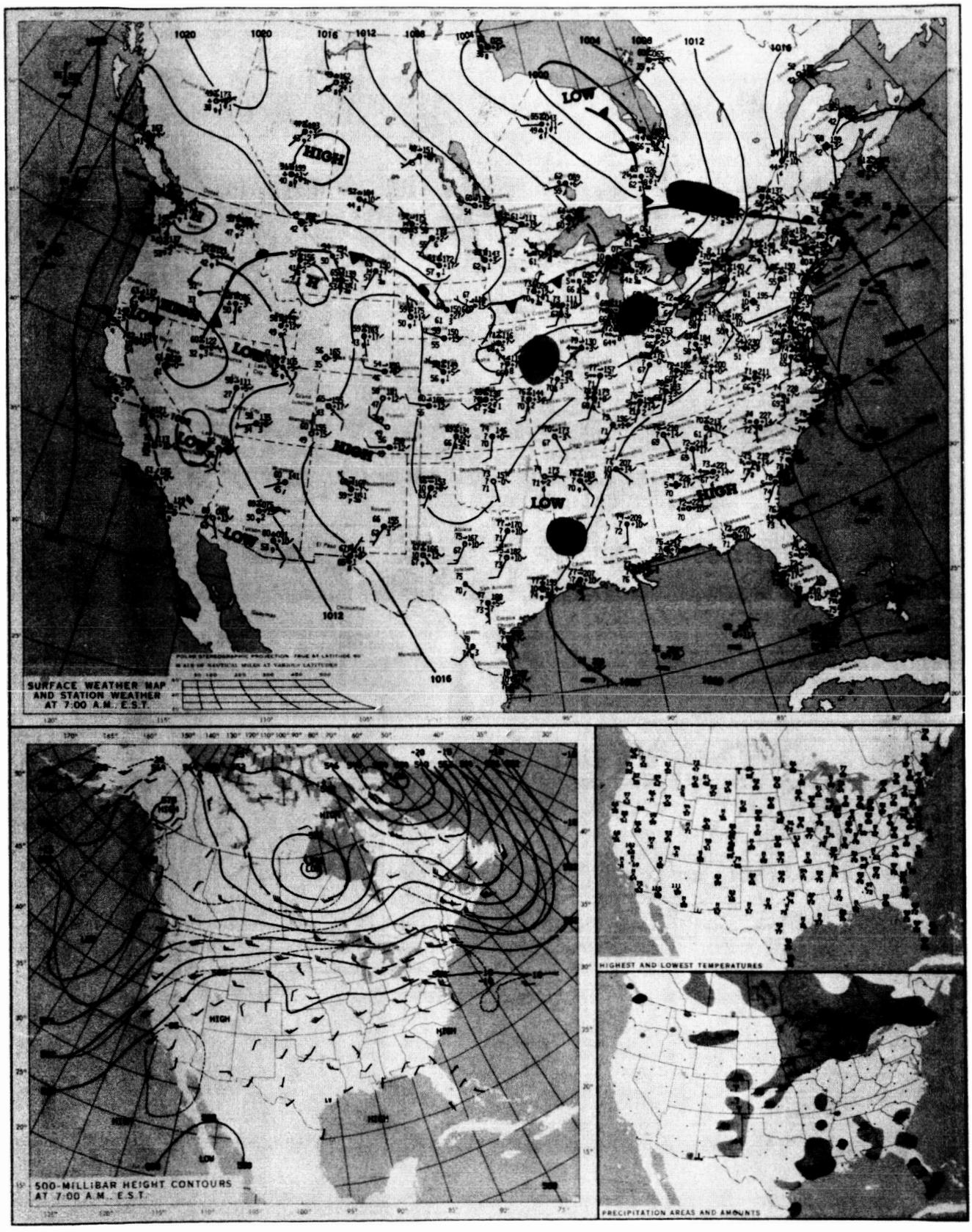


Fig. 3.2-26a. Synoptic weather conditions for 27 June 1986 1200 GMT

OPERATIONAL SUMMARY

27 June 1986

Rawinsonde Operations

A full rawinsonde operation was conducted at 3-h intervals from 1800 to 0000 GMT. Unfortunately, Hazel Green, a critical station location for both the cloud and sounding ER-2 missions, was not able to make the 2100 and 0000 GMT soundings.

Radar Operations

CP-4 acquired mostly surveillance scans and some RHIs during the afternoon hours. CP-2 and CP-3 accomplished three sets of dual Doppler scans from 1800 to 1900, from 2035 to 2100, and from 2130 to 2200 GMT. Dual Doppler targets were generally weakly precipitating convective clouds having short lifetimes. CP-2 also provided PPI and RHI scans in support of the ER-2 overpass flights from 2000 to 2115.

Satellite Operations

The start of RISOP at 2000 GMT terminated GOES VAS products shortly before the ER-2 arrived over the beta network.

Aircraft Operations

The ER-2 conducted a combined cloud and sounding mission over the beta network from 2000 to 2330 GMT. Scattered convective clouds located over the eastern SPACE network were sampled along CP-2 radial flight legs (70° radial) from 2000 to 2100 GMT. Some of these were moderately intense (tops to 12 km and reflectivity factor to 55-60 dBZ), and others were weak. After 2115 GMT three east-west sounding flight legs were flown over northern Alabama and southern Tennessee.

The T-28 acquired some limited cloud penetration data within weak convective clouds from 2100 to 2135 GMT. At least one of the penetrations was coordinated with an ER-2 overpass. However, cloud intensity and coverage weakened after the T-28 arrived for research work.

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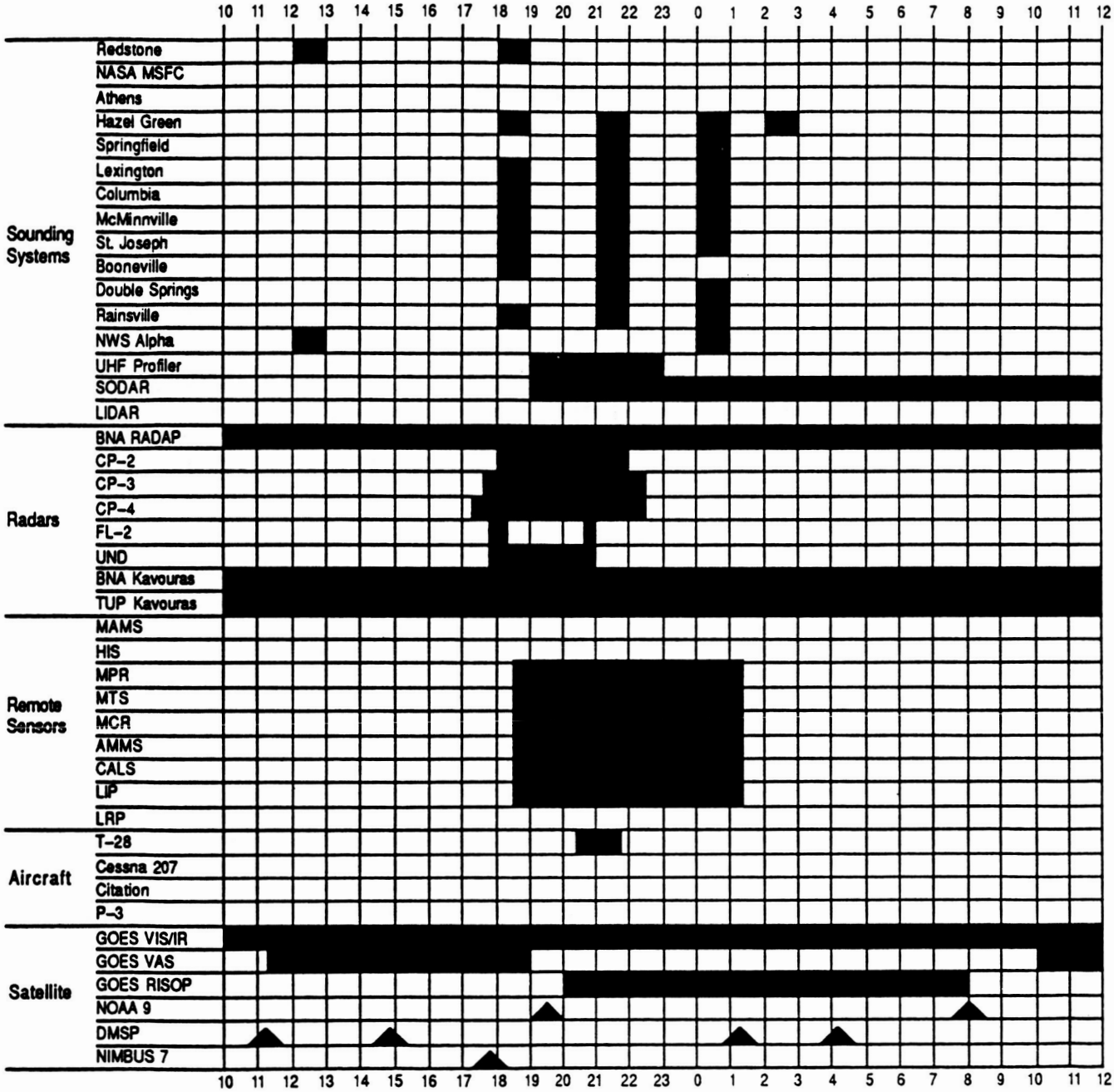
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Day: FRIDAY
Date: 6/27/86
Julian Day: 178–179

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 12, 16 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

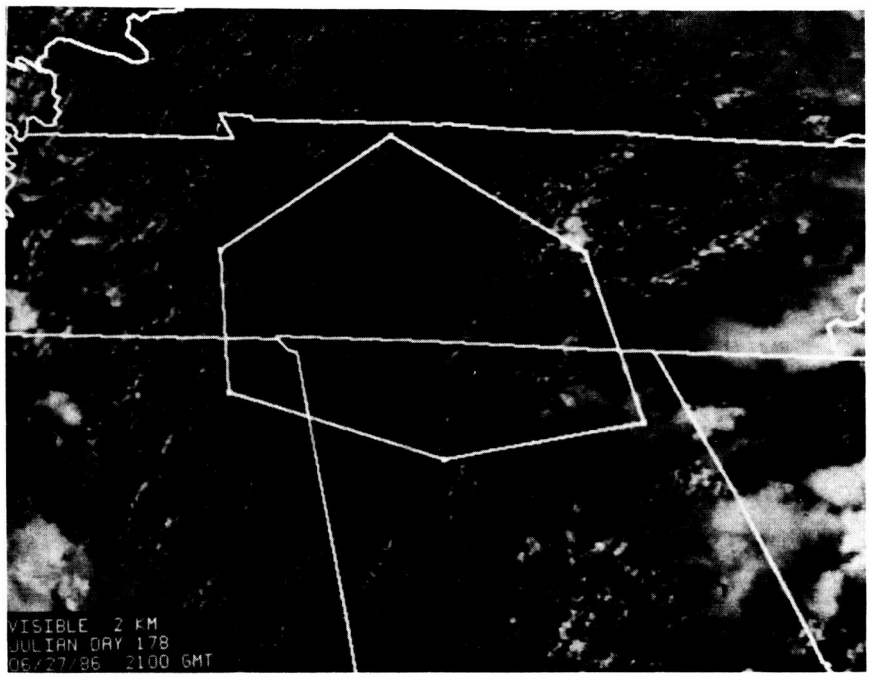


Fig. 3.2-26b. Visible 2 km GOES Central satellite image for 27 June 1986 2100 GMT

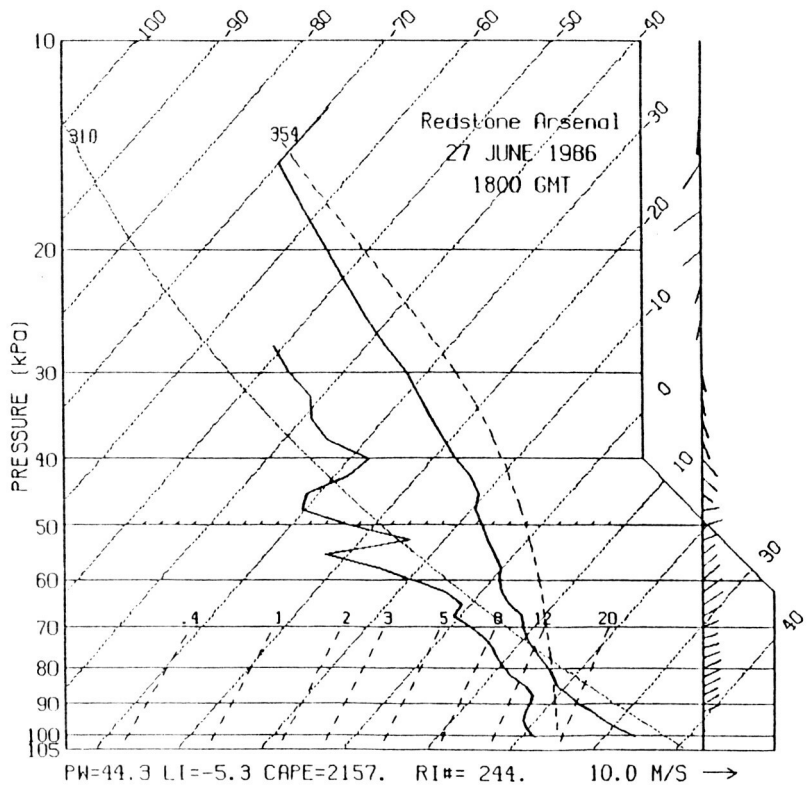


Fig. 3.2-26c. Redstone Arsenal, AL, rawinsonde sounding for 27 June 1986 1800 GMT

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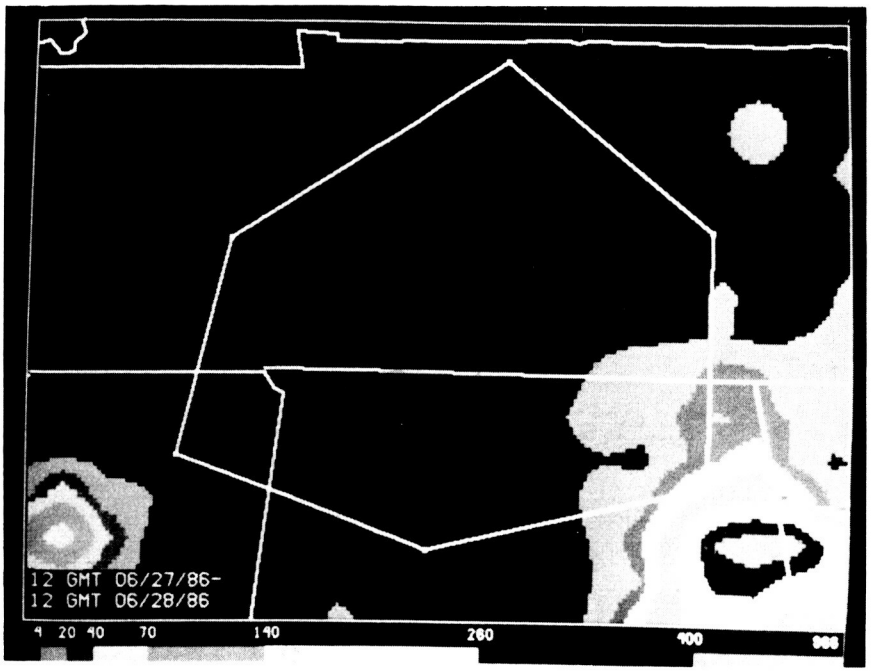


Fig. 3.2-26d. Twenty-four hour lightning strike density plot for 27-28 June 1986

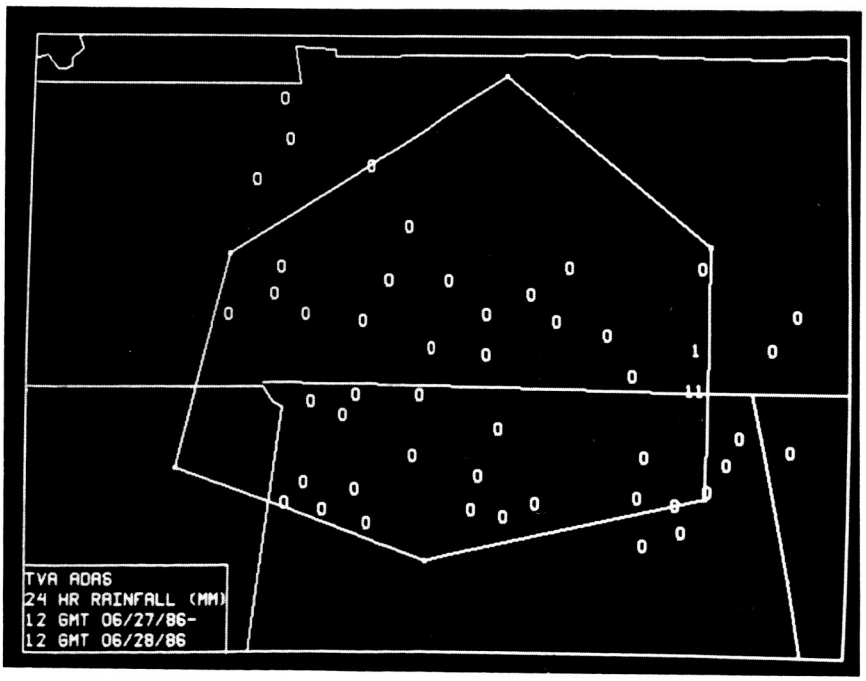


Fig. 3.2-26e. Twenty-four hour TVA ADAS rainfall totals (mm) for 27-28 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

28 June 1986

Synoptic Conditions

The 1200 GMT 6.7 micrometer water vapor image indicated abundant moisture associated with the remnants of Hurricane Bonnie over Mississippi. Flow features at 500 mb included a prominent but slow moving short wave trough at middle levels that moved over the SPACE mesonet late in the day. The 1200 GMT RSA sounding indicated that temperatures over the lowest 200 mb had cooled by 1-2 K from values 24 h earlier, thereby lowering moist static stability from yesterday's values. Winds were strongest at ~20 m s^{-1} near 750 mb, weakening above and below that point. Afternoon surface temperatures and dewpoints over the SPACE mesonet were relatively cool and moist at 24-26 °C and 22-23 °C, respectively.

Cloud/Precipitation Overview

Low to middle level cloudiness (associated with Bonnie remnants) was prevalent over much of the beta network throughout the day. An associated large area of weak rain showers moved into the western beta network by 1200 GMT. These showers persisted over the mesonet for the remainder of the day, intensifying over the northwestern mesonet by 2000 GMT, and over the central mesonet from 2300 to 0100 GMT. Typical shower producing clouds from late morning to early afternoon were small, short-lived, and attained echo tops of only 6-8 km despite attaining 50 dBZ intensities. From 2300 to 0300 GMT, a longer-lived cluster of thunderstorms evolved over south-central Tennessee and northern Alabama. This mesoscale cluster, as well as individual intense storms within the cluster, exhibited cyclonic rotation, and apparently produced heavy rainfall over southern Tennessee, 40-80 km north of the MIST/FLOWS network. After a lull in activity after 0500 GMT, intense thunderstorms redeveloped over northern Alabama around 0930-1200 GMT 29 June. Rainfall amounts from these latter storms approached 50-80 mm over much of the MIST/FLOWS network. Over the beta network, 24-h rainfall totals generally peaked over the central to eastern portion, where rainfall amounts peaked near 40-60 mm.

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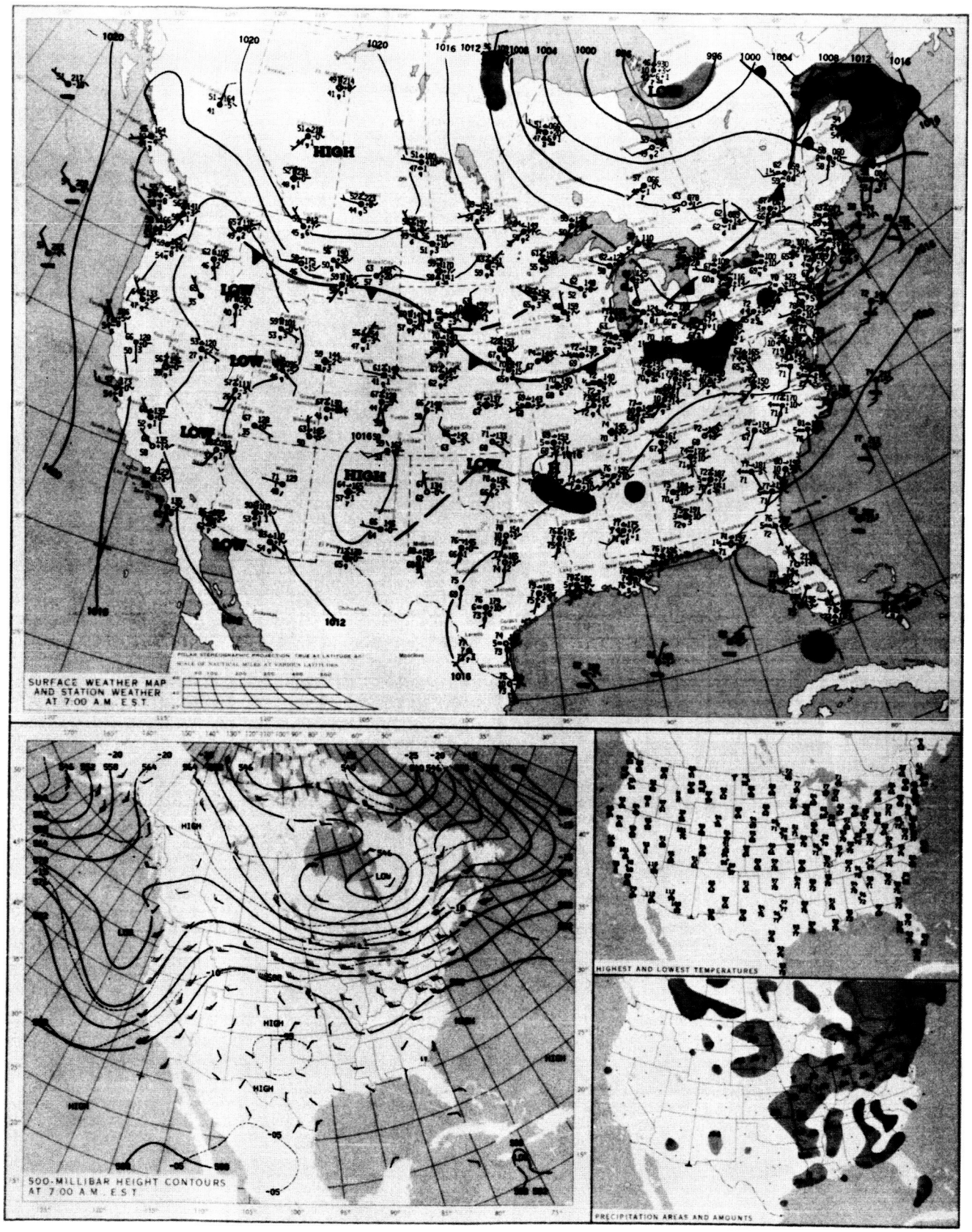


Fig. 3.2-27a. Synoptic weather conditions for 28 June 1986 1200 GMT

OPERATIONAL SUMMARY

28 June 1986

Rawinsonde Operations

A very successful and nearly complete 3-h interval rawinsonde operation was conducted over the SPACE mesonet from 1500 to 0300 GMT, and over the Meso-alpha (NWS) network from 1200 GMT 28 June to 1200 GMT 29 June. These data should afford a detailed analysis of storm initiation and system water budget.

Radar Operations

Radar coverage in general appears very good throughout the day. CP-4 provided primarily surveillance scans from 1630 to 2230 GMT, and miscellaneous sector scans of storms 40-80 km to the north from 2230 to 0300 GMT. CP-2 conducted miscellaneous scans throughout this period. From 2015 to 2245 GMT, CP-2 scanned a line of storms to the distant northwest in support of the ER-2. After 2355 GMT, CP-2 scanned the northern and western quadrants as storms became active over southern Tennessee. Dual Doppler scans (with CP-2 and CP-3) were acquired on weak to moderate cells, covering the western sector being examined by the T-28, from 2235 to 2355 GMT. Cells under coverage exhibited reflectivity factor greater than 55 dBZ and tops to 12 km. Maximum reflectivity factors were most common beneath the melting level.

Satellite Operations

Due to the abundance of low to middle level clouds over the beta network, VAS coverage was limited through 1830 GMT. RISOP was started at 1830 GMT and should capture the organizing stages of deep convection over the beta network during the afternoon hours.

Aircraft Operations

The ER-2 (MPR, MTS, MCR, AMMS, CLS, LIP) flew the western portion of the beta network from 2000 to 2145 GMT, and then made two passes over developing convection 70 km west of CP-2 before leaving the beta network at 2245 GMT.

From 2225 to 2320 GMT, the T-28 accomplished six penetrations through weak to moderately intense convective cells exhibiting peak reflectivities near 50 dBZ. One pass at 2240 GMT was coordinated with an ER-2 overflight, while the subsequent five penetrations were done more independently under Doppler radar coverage, west and northwest of the Doppler radar network. High liquid water contents and appreciable turbulence were reported during some of these penetrations, but updraft and downdraft intensities were not great.

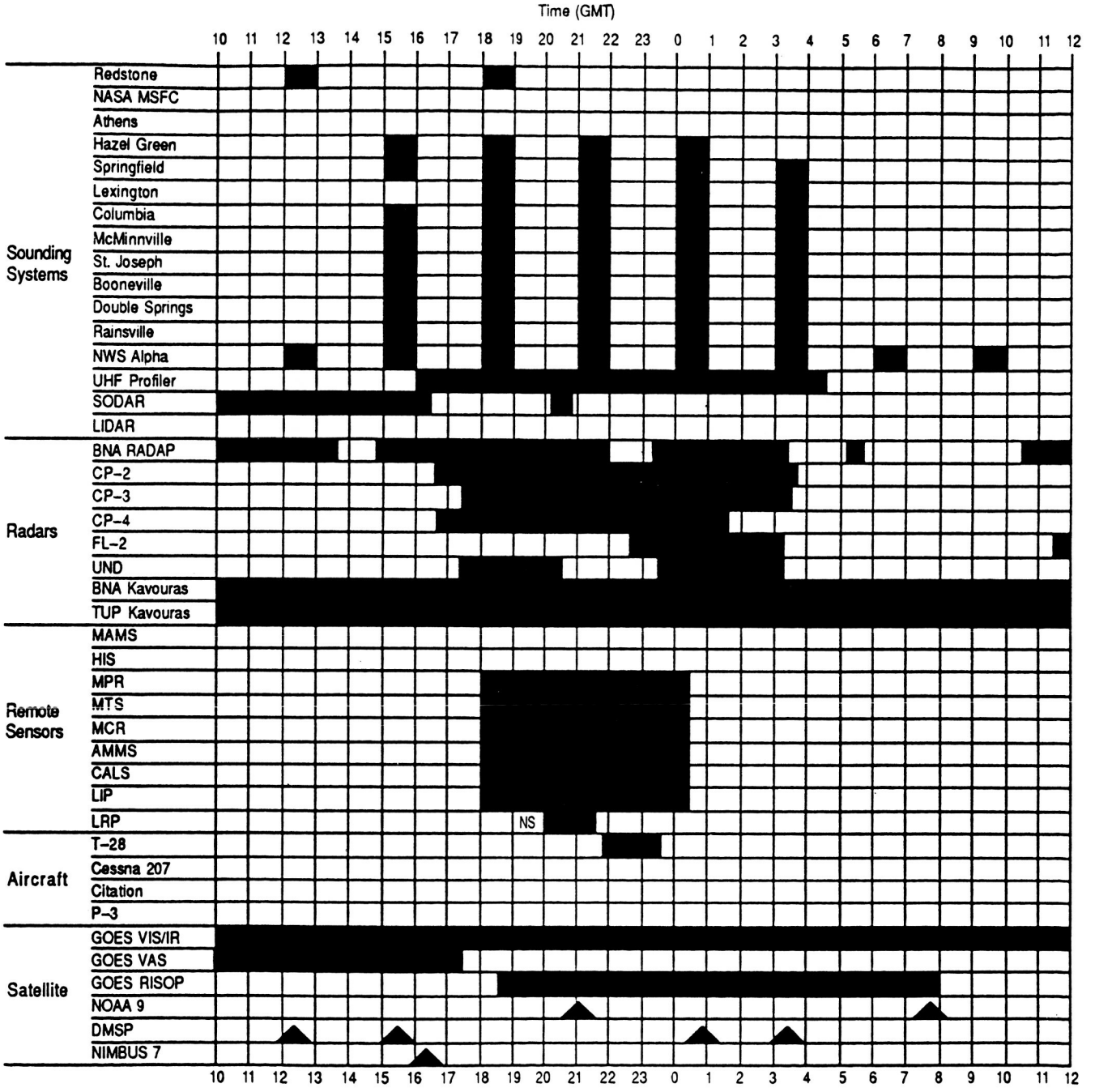
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Day: SATURDAY
Date: 6/28/86
Julian Day: 179—180

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 12, 16, 21 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL



Fig. 3.2-27b. Visible 2 km GOES Central satellite image for 28 June 1986 2300 GMT

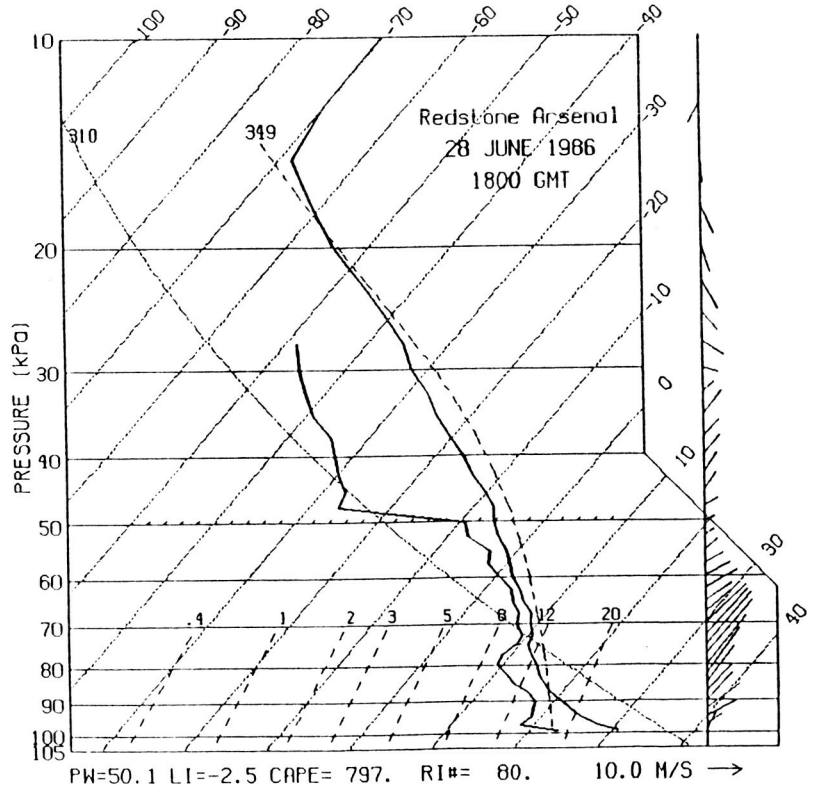


Fig. 3.2-27c. Redstone Arsenal, AL, rawinsonde sounding for 28 June 1986 1800 GMT

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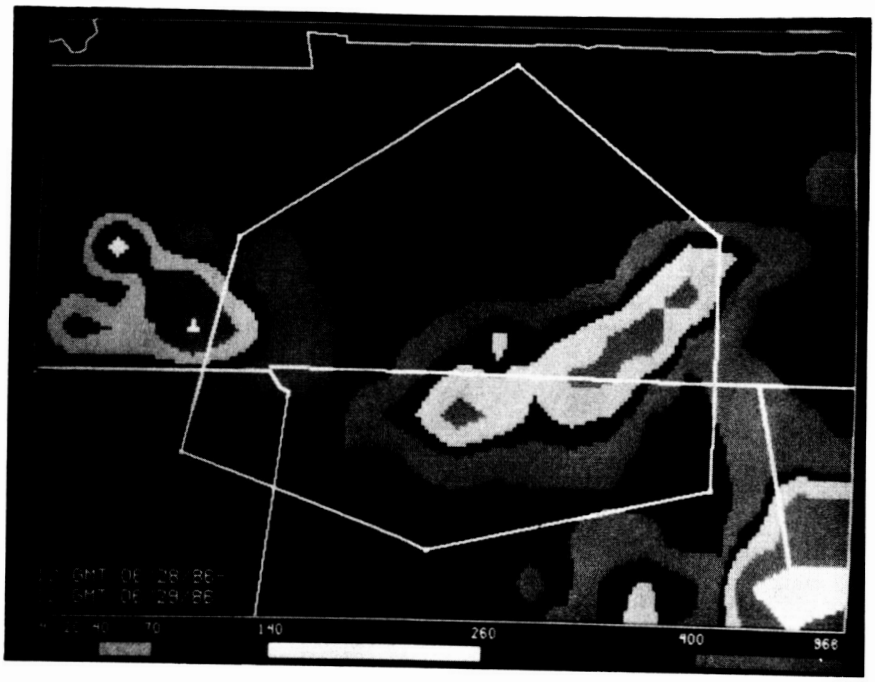


Fig. 3.2-27d. Twenty-four hour lightning strike density plot for 28-29 June 1986



Fig. 3.2-27e. Twenty-four hour TVA ADAS rainfall totals (mm) for 28-29 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

29 June 1986

Synoptic Conditions

The slow moving trough visible over the SPACE mesonet yesterday moved out of the eastern portion of the mesonet by 1800 GMT. However, both total precipitable water and moist static instability remained high. Flow aloft was light and westerly at low levels, switching to a moderate easterly flow at middle to upper levels. Surface features over the mesonet were uniform, with afternoon temperature and dewpoint values of 28-30 °C and 22-23 °C.

Cloud/Precipitation Overview

An early morning convective system which may have been an extension of last night's activity, passed through the MIST/FLOWS and south-central SPACE networks near 1200 GMT. Locally heavy rains up to 85 mm were produced over the MIST/FLOWS mesonet. This system was a line about 300 km long oriented northeast to southwest. After 1700 GMT more scattered but intense thunderstorm activity redeveloped over the beta network and remained until 2300 GMT. Several microbursts were detected from both the early morning and early to middle afternoon activity.

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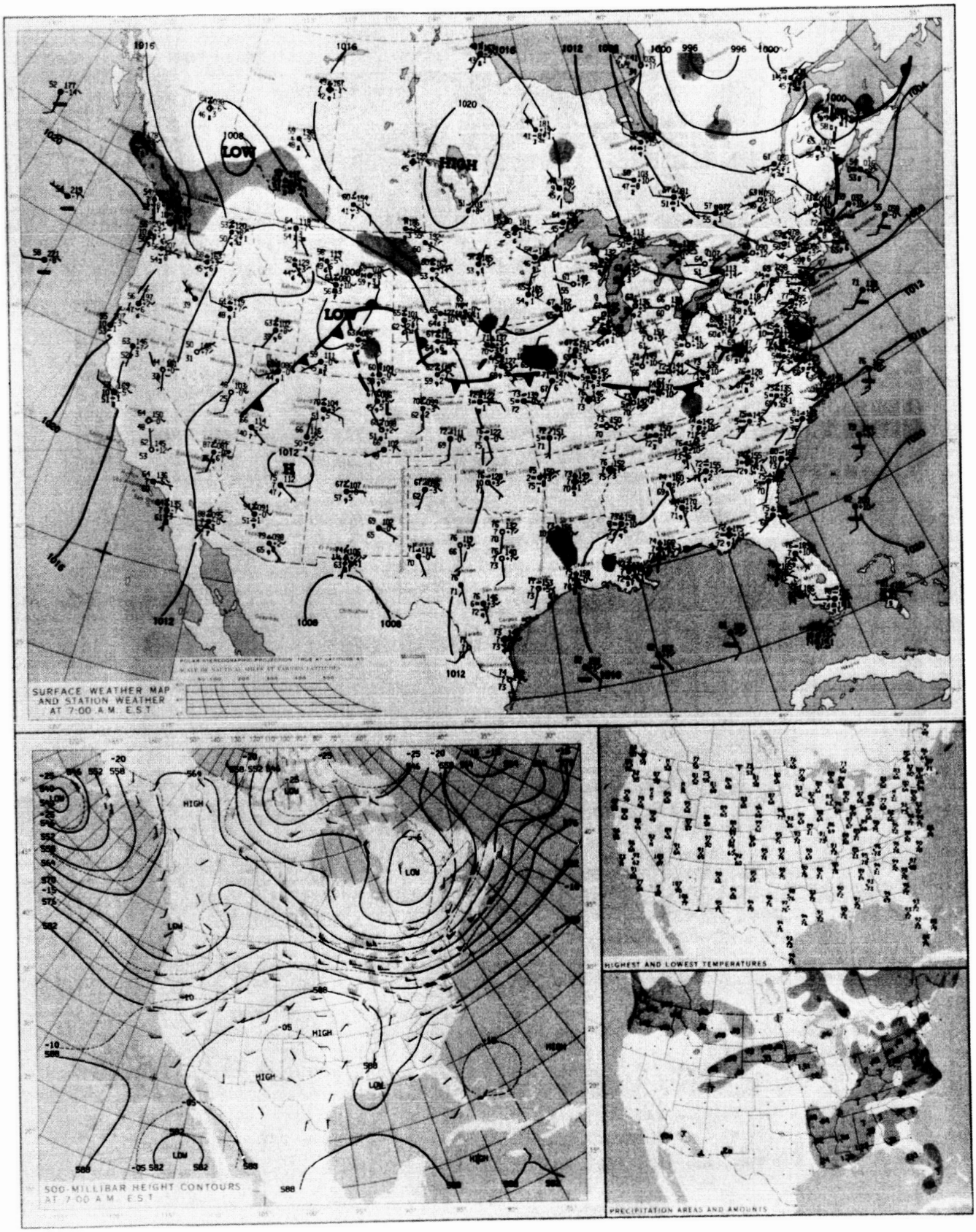


Fig. 3.2-28a. Synoptic weather conditions for 29 June 1986 1200 GMT

OPERATIONAL SUMMARY

29 June 1986

Rawinsonde Operations

The normal 1200 and 1800 GMT RSA soundings were taken.

Radar Operations

The NCAR Doppler radars did not operate. FL-2 and UND collected data from both early morning activity and afternoon activity. FL-2 personnel observed several microbursts associated with the morning thunderstorms. Maximum tops and reflectivity factor were 14 km and 55 dBZ, respectively. The afternoon activity northwest of the MIST/FLOWS network also produced strong reflectivity factor and strong low level divergence.

Satellite Operations

RISOP was started at 1700 GMT.

Aircraft Operations

The Citation conducted a 2.3 h morning flight (1406-1624 GMT) on an organized system. Box patterns were flown around cells apparently located within stratiform precipitation southeast of FL-2. Icing was observed above the freezing level, and wind shifts were noted through the melting layer. Later on weak showers over HSV were penetrated at middle levels.

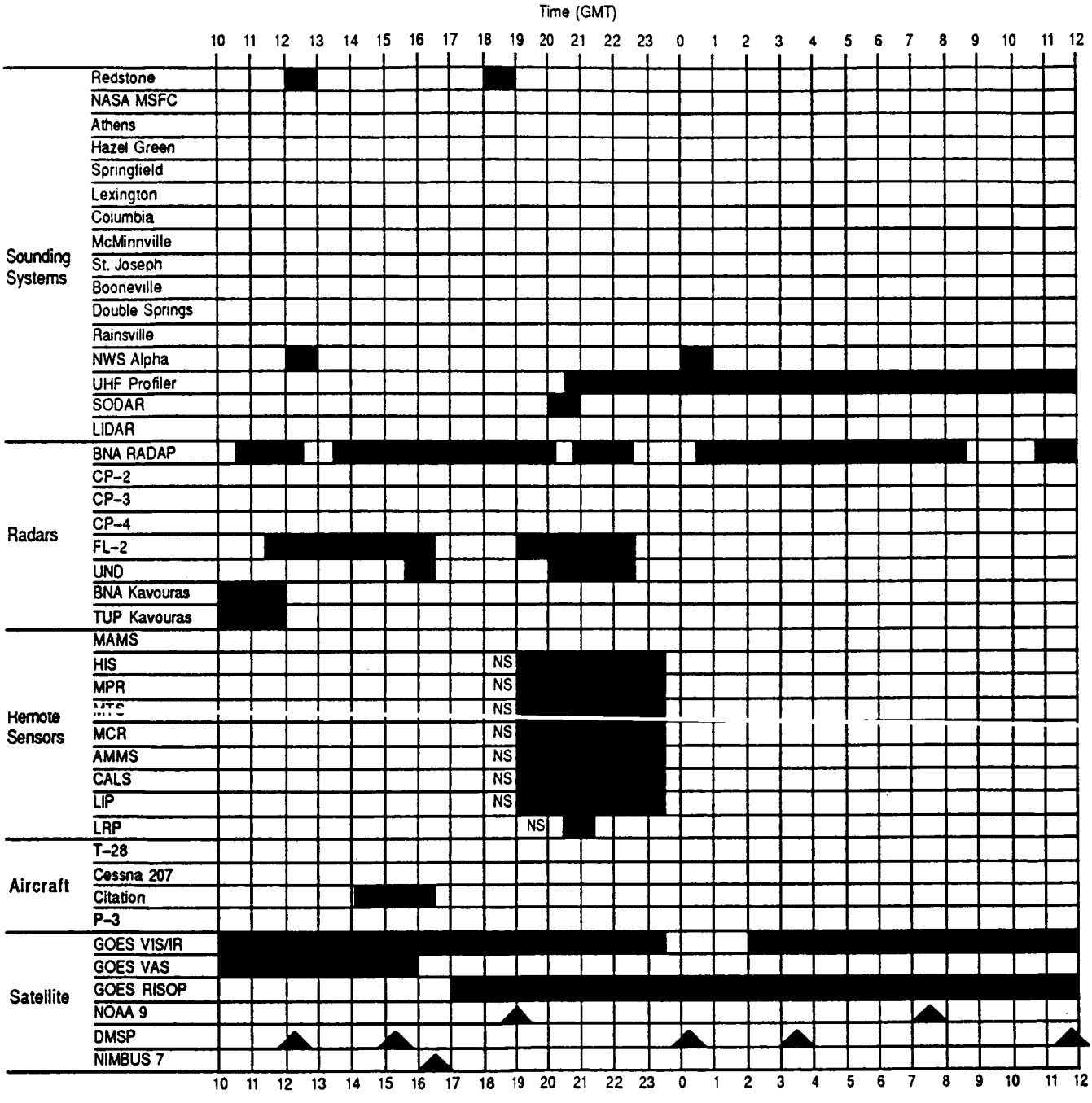
Notes:

5-550-7-8(28)

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Day: SUNDAY
Date: 6/29/86
Julian Day: 180–181

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS12, 16 & 45
	LLP	OPERATIONAL– NO DATA ON ARCHIVE TAPE
	Mobile Lab	1312–0154 GMT; 2 BALLOONS LAUNCHED FROM RSA EXCELLENT DATA



Fig. 3.2-28b. Visible 2 km GOES Central satellite image for 29 June 1986 1301 GMT

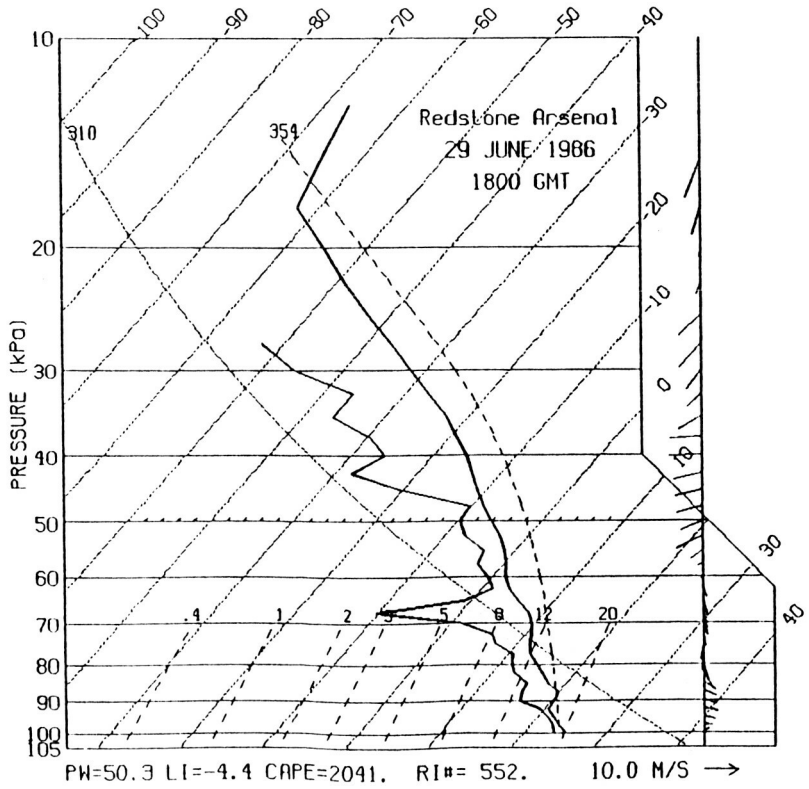


Fig. 3.2-28c. Redstone Arsenal, AL, rawinsonde sounding for 29 June 1986 1800 GMT

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NO ARCHIVE DATA AVAILABLE

Fig. 3.2-28d. Twenty-four hour lightning strike density plot for 29-30 June 1986

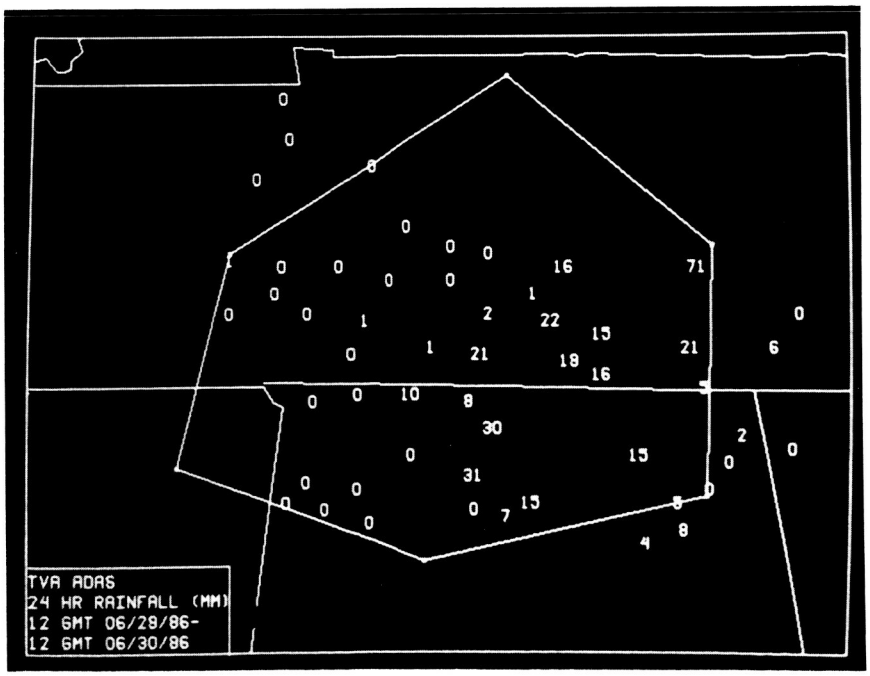


Fig. 3.2-28e. Twenty-four hour TVA ADAS rainfall totals (mm) for 29-30 June 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

30 June 1986

Synoptic Conditions

Very weak westerly flow persisted from the low to upper levels over the mesonet during the day. Total precipitable water remained uniformly very high over the region, and moist static instability decreased to moderate levels (CAPE ~ 1200 J kg^{-1}). Over the SPACE mesonet, afternoon surface temperature and dewpoint values were 30-32 °C and 21-23 °C in the presence of 3-5 m s^{-1} southwesterly flow.

Cloud/Precipitation Overview

An early morning overcast of stratus and stratocumulus gave way to clearing skies over northern Alabama and southern Tennessee by late morning. From late morning to early afternoon, cumulus mediocris and cumulus congestus clouds were common, but their vigor and cover decreased after 1900 GMT. Afternoon precipitating convection was isolated over the SPACE mesonet. Only the northern border of the beta network experienced widespread and relatively intense showers and thunderstorms. Isolated, weak and short-lived showers existed over the remainder of the beta network. One interesting cloud pattern feature that appeared in both radar and satellite pictures was an arc of clouds (apparently marking a boundary) located in the northwest corner of Alabama.

Notes:

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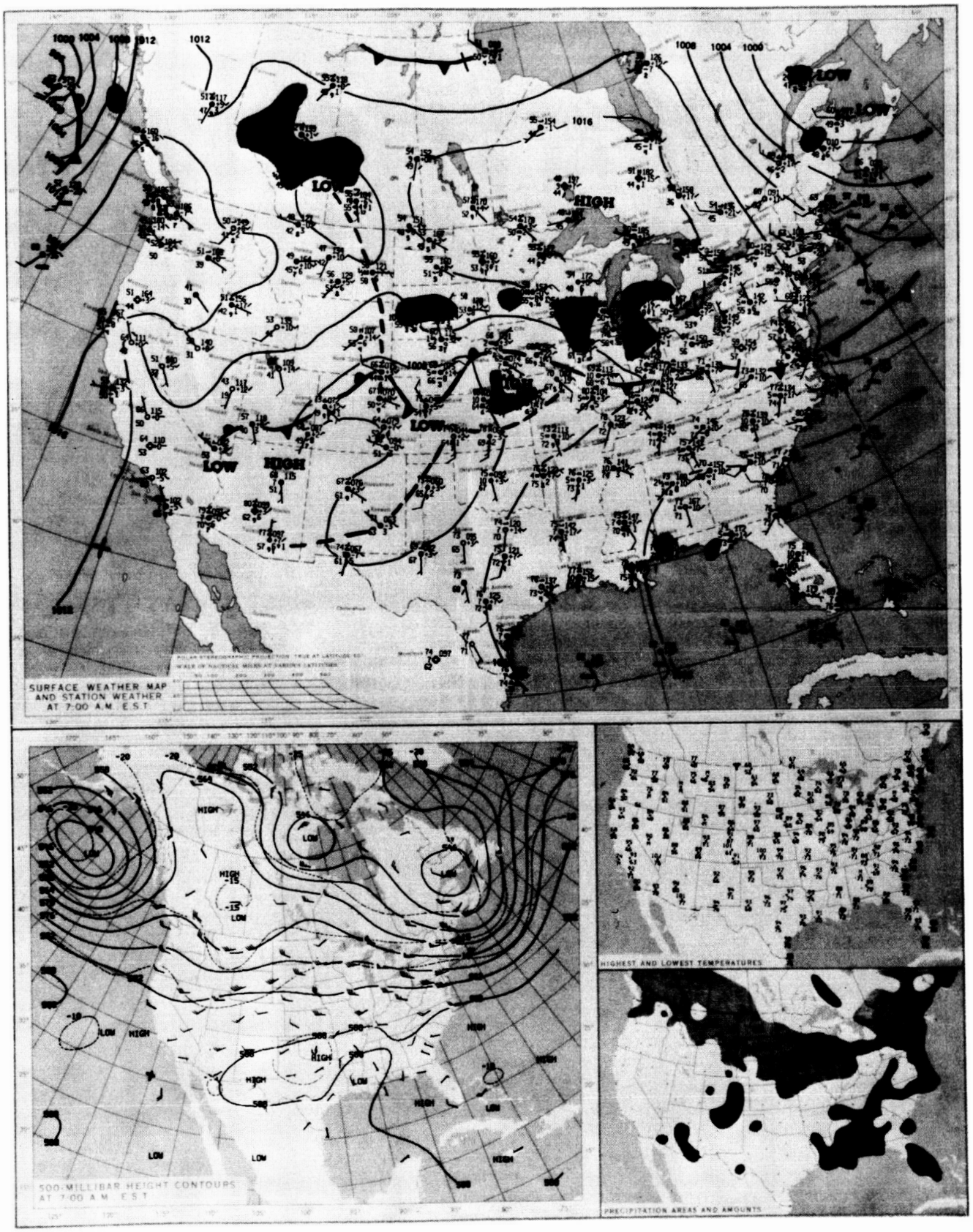


Fig. 3.2-29a. Synoptic weather conditions for 30 June 1986 1200 GMT

OPERATIONAL SUMMARY

30 June 1986

Rawinsonde Operations

The only special soundings were taken from RSA at 1200 and 1800 GMT.

Radar Operations

Few precipitation targets were within 100 km range from CP-4. CP-2, CP-3 and CP-4 supported the P-3 aircraft during its flight over northwest Alabama, CP-4 and CP-2 conducted primarily surveillance scans otherwise. Clear air return was good up to 5 km AGL. Most precipitation echoes were located in the western and northern quadrants.

Satellite Operations

RISOP was in effect all day; therefore, VAS products were not acquired.

Aircraft Operations

The P-3 aircraft acquired measurements of convective clouds located over northwest Alabama and northern Mississippi. The cloud systems in northwest Alabama were generally small enough to allow P-3 fly-overs, with some limited ground based radar support. Box patterns were flown on the larger and more intense cloud systems in northern Mississippi.

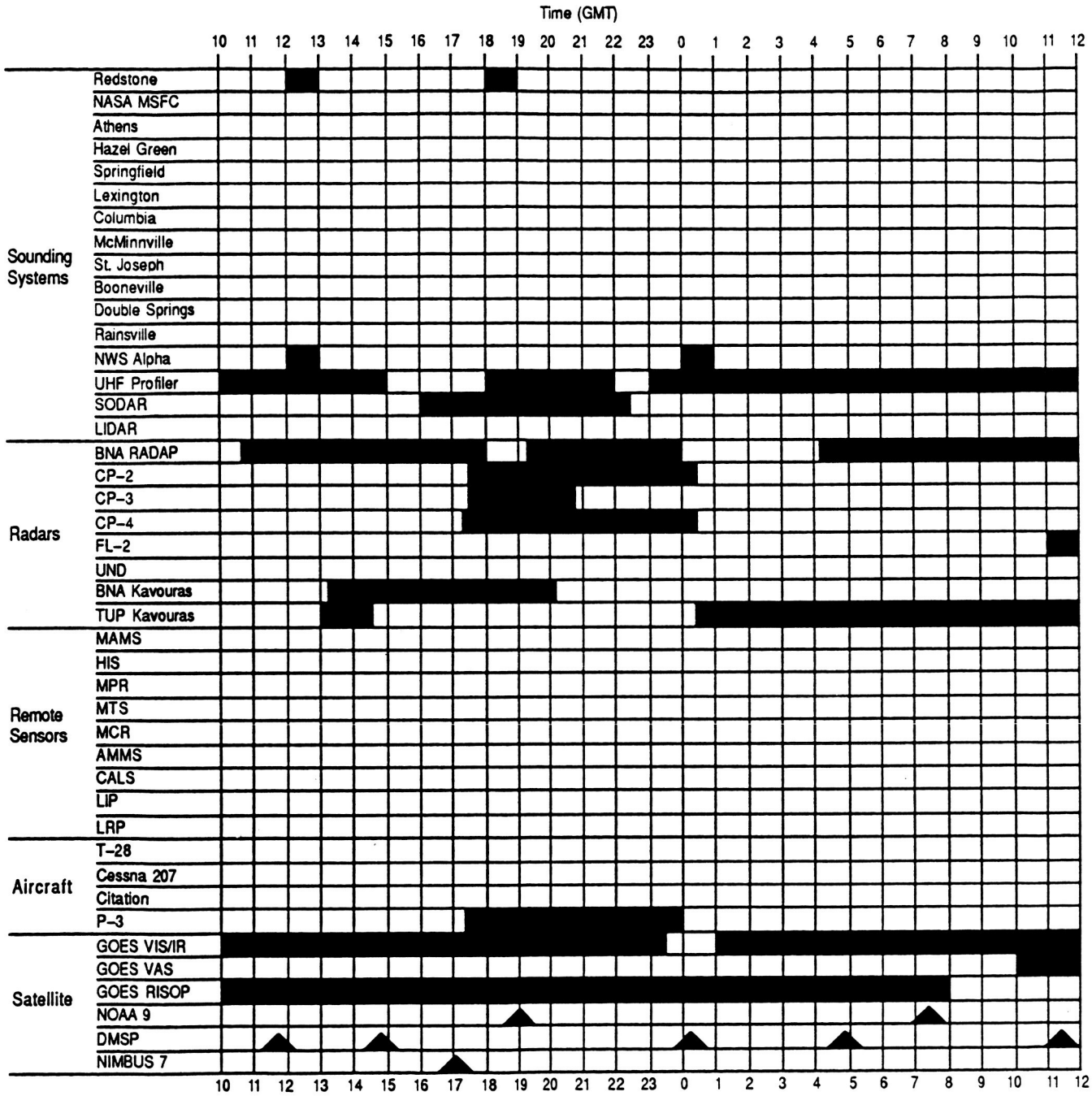
Notes:

5-550-7-8(29)

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Day: MONDAY
Date: 6/30/86
Julian Day: 181–182

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 12, 16 & 45
	LLP	OPERATIONAL– NO DATA ON ARCHIVE TAPE
	Mobile Lab	NOT OPERATIONAL

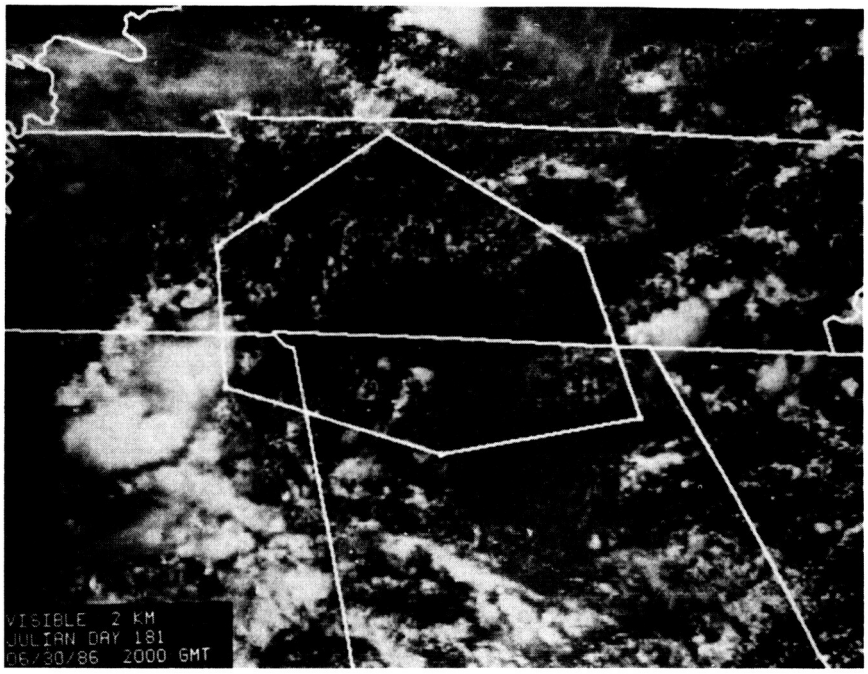


Fig. 3.2-29b. Visible 2 km GOES Central satellite image for 30 June 1986 2000 GMT

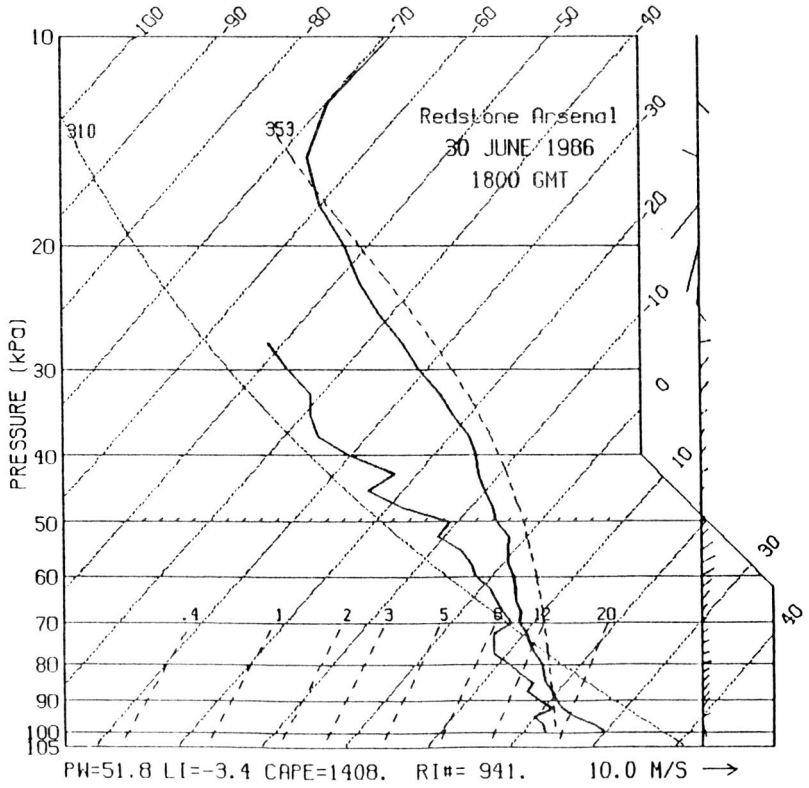


Fig. 3.2-29c. Redstone Arsenal, AL, rawinsonde sounding for 30 June 1986 1800 GMT

30 June 1986

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NO ARCHIVE DATA AVAILABLE

Fig. 3.2-29d. Twenty-four hour lightning strike density plot for 30 June - 1 July 1986

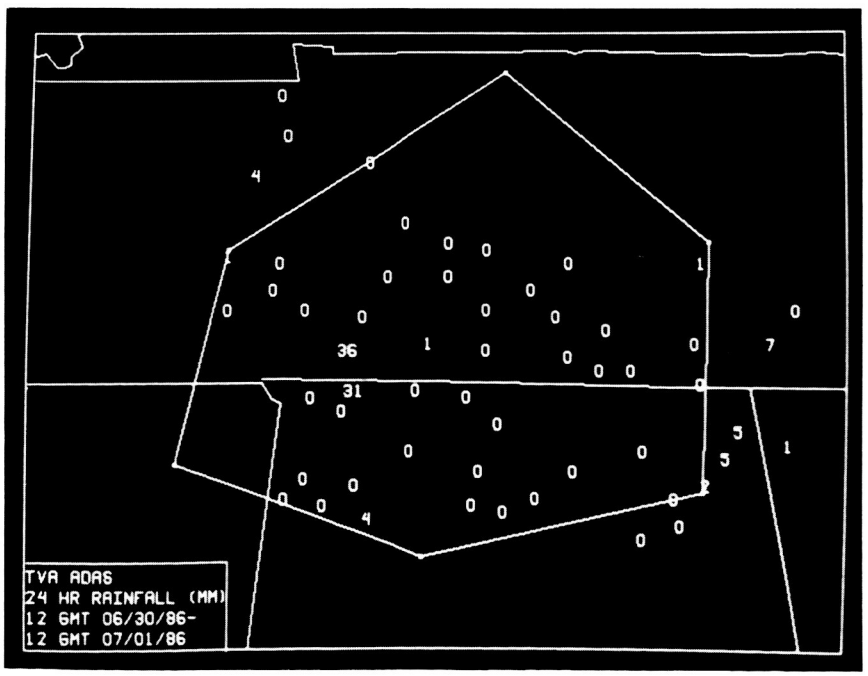


Fig. 3.2-29e. Twenty-four hour TVA ADAS rainfall totals (mm) for 30 June - 1 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

1 July 1986

Synoptic Conditions

Upper level flow was primarily zonal over the eastern one-half of the U.S. Over the SPACE network a north-south gradient in zonal wind is apparent in the 1200 GMT NMC analysis at 500 mb. Winds aloft exhibit moderately strong zonal flow from lower to middle levels. To the northwest, a short wave trough was moving over the Dakotas at 1200 GMT. At the surface, a weak low over northeastern Kansas developed in response to the upper level trough, and the cold front associated with it moved into the SPACE network 24 h later. Afternoon surface temperature and dewpoint values over the SPACE network were relatively uniform at ~31 and ~22 °C, respectively. Surface flow was west-southwesterly at ~5 m s^{-1}.

Cloud/Precipitation Overview

Scattered rain showers developed early by about 1130 GMT over the southern SPACE mesonet. During the morning hours these showers increased in intensity and aerial coverage, forming a general line oriented northwest to southeast by 1530 GMT. This line persisted along with other scattered convective activity throughout the early afternoon hours. Some relatively intense microburst producing thunderstorms formed over and just north of the MIST/FLOWS network during the early afternoon hours. Locally heavy rains to near 50 mm accumulation were recorded at two PAM sites in the MIST/FLOWS network. Convective activity became more scattered after 1900 GMT, with the widespread activity having shifted northeast of the beta network. One relatively intense thunderstorm complex located 50 km north of CP-2 was closely studied by the P-3, the NSSL chase van, and other ground based Doppler radars. FL-2 radar personnel reported 9 microbursts (some strong) and 2 gust front events during the day. Rainfall was recorded at nearly every SPACE mesonet station during the day.

Notes:

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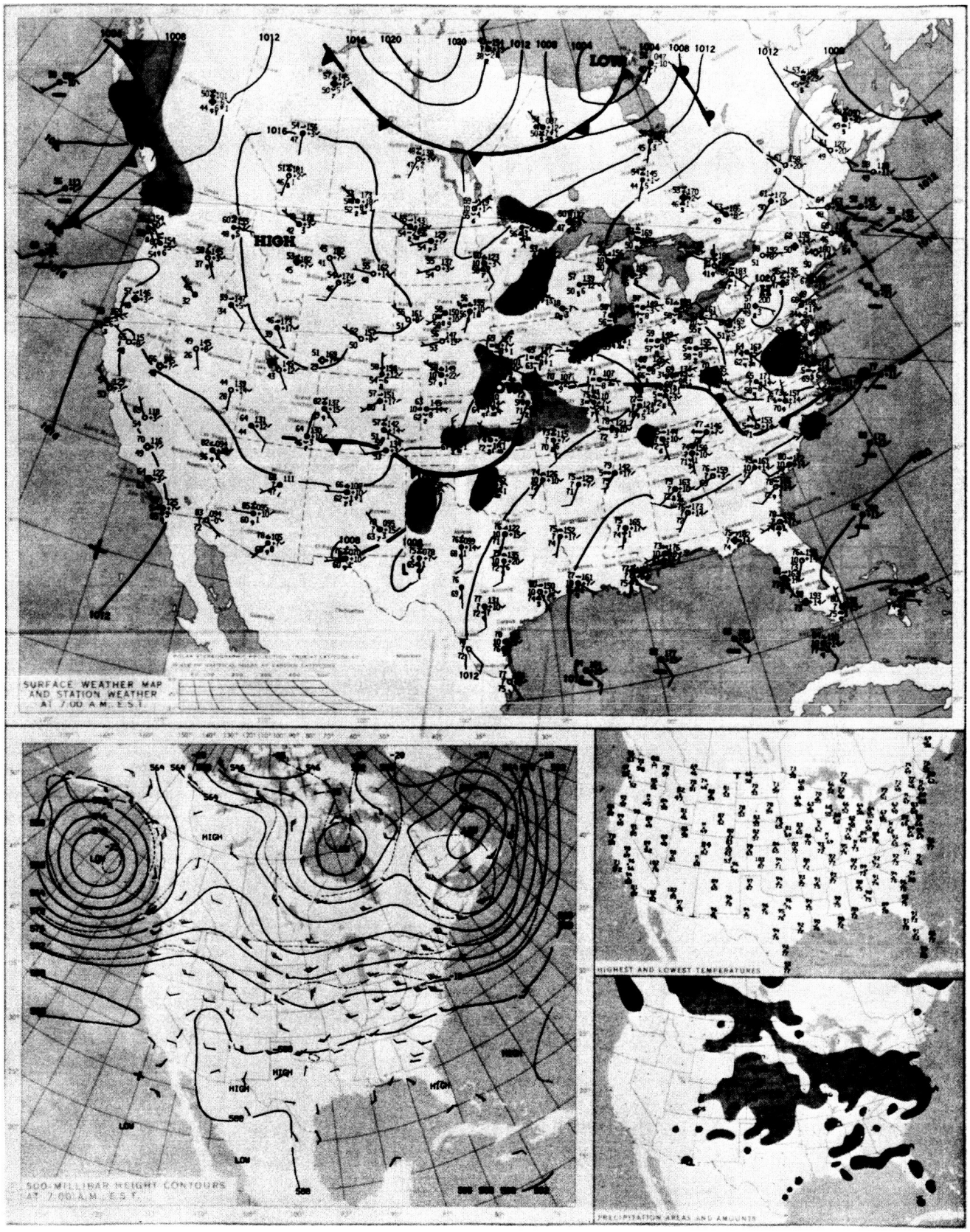


Fig. 3.2-30a. Synoptic weather conditions for 1 July 1986 1200 GMT

OPERATIONAL SUMMARY

1 July 1986

Rawinsonde Operations

Only the 1200 and 1800 GMT RSA soundings were taken.

Radar Operations

The Doppler radars conducted dual Doppler scans on a couple of convective cells within the MIST/FLOWS region during the early afternoon hours. Miscellaneous scans were conducted otherwise. Radar coverage of the storm sampled by the P-3, located 50 km north of CP-2, appears to be good.

Satellite Operations

Normal satellite operations were conducted.

Aircraft Operations

The P-3 sampled scattered convection over the beta network from 1800 to 2330 GMT, spending most research time on a fairly vigorous multicell storm located ~50 km north of CP-2. Several boxes and sawtooth patterns were flown on this. The Citation (2240-2340 GMT) initially sampled gust fronts at low levels on the same storm being sampled by the P-3. Towards the end of the mission, an environmental sounding was acquired between 5,000 and 23,000 ft near dissipating convection.

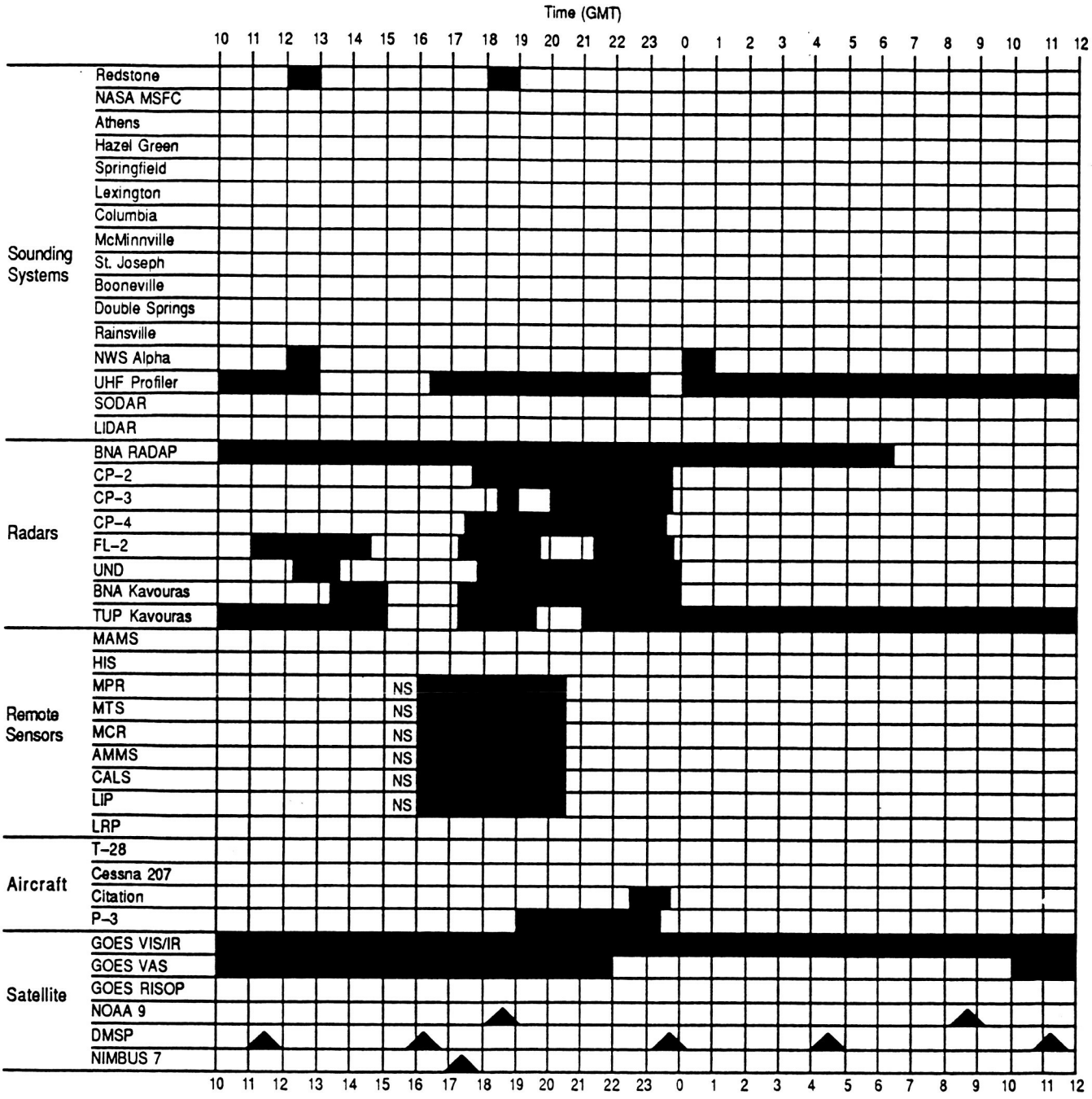
Notes:

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5-550-7-8(30)

Day: TUESDAY
Date: 7/1/86
Julian Day: 182–183

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	1745–1920 GMT; DATA MAY NOT BE AVAILABLE
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 12, 16, 21, 33 & 45
	LLP	OPERATIONAL
	Mobile Lab	1845–2310 GMT; BALLOON LAUNCHES

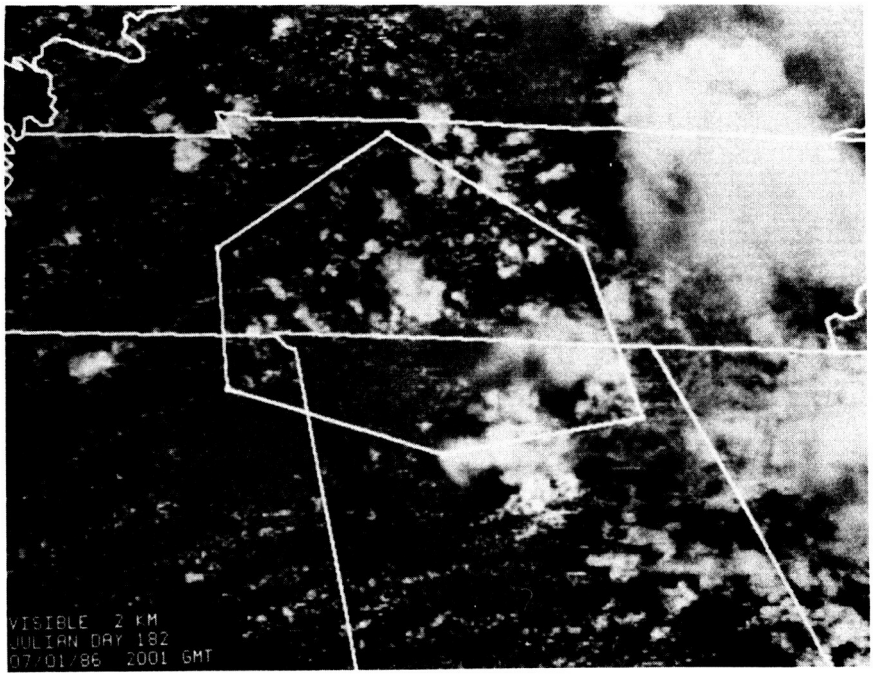


Fig. 3.2-30b. Visible 2 km GOES Central satellite image for 1 July 1986 2001 GMT

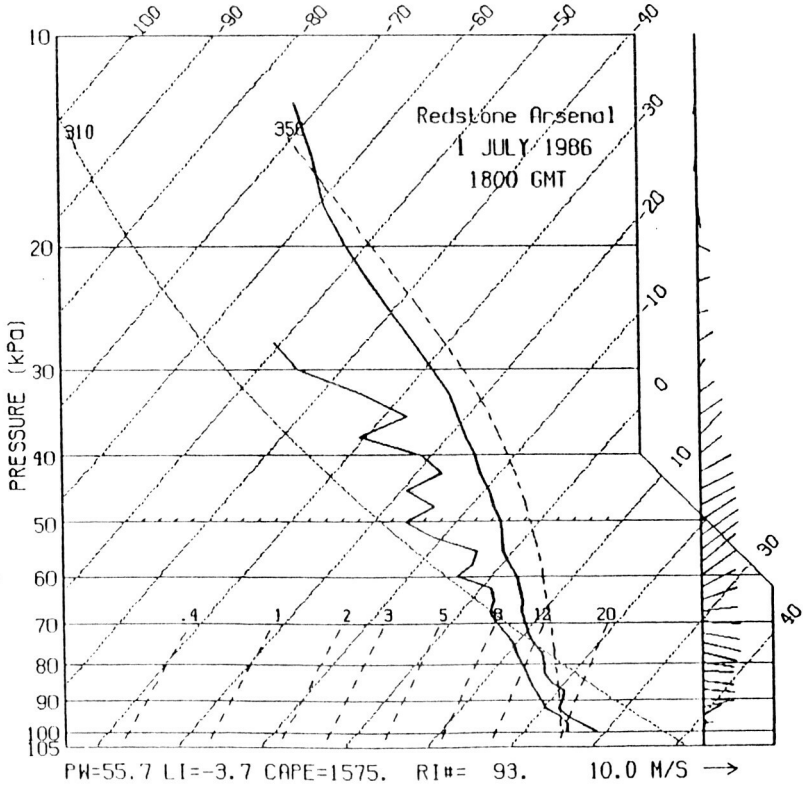


Fig. 3.2-30c. Redstone Arsenal, AL, rawinsonde sounding for 1 July 1986 1800 GMT

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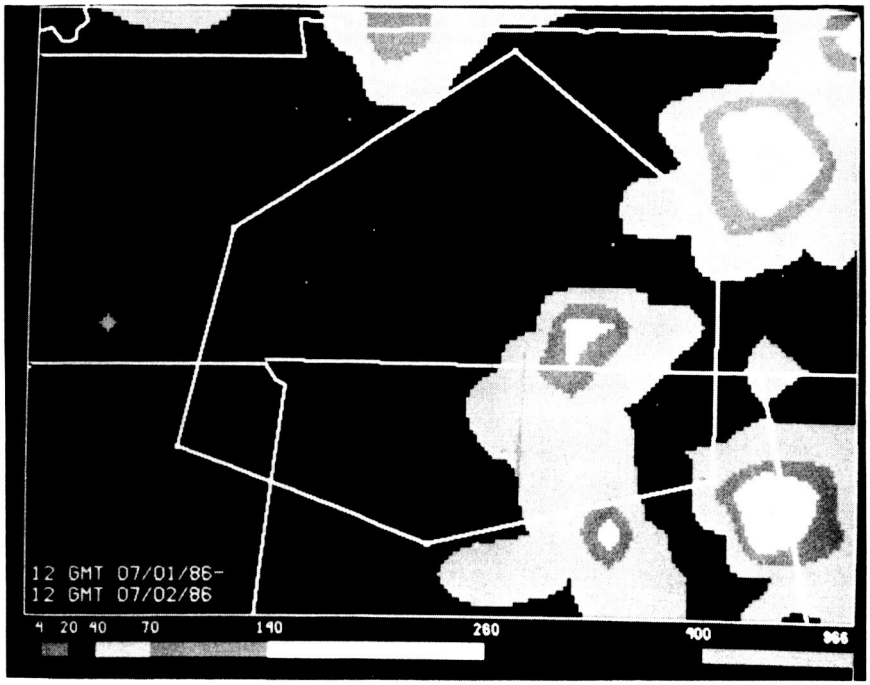


Fig. 3.2-30d. Twenty-four hour lightning strike density plot for 1-2 July 1986

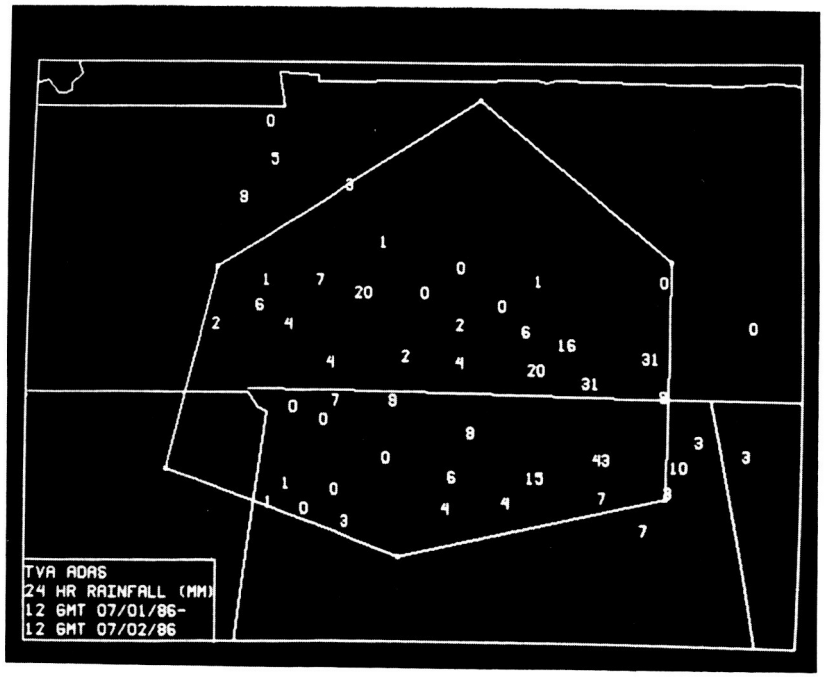


Fig. 3.2-30e. Twenty-four hour TVA ADAS rainfall totals (mm) for 1-2 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

2 July 1986

Synoptic Conditions

The cold front located over the Midwest yesterday continued its relatively rapid southeastward translation, having moved into the northwestern corner of the SPACE mesonet by 1200 GMT today. As it did so, rain and moderately weak showers formed just ahead of and along the surface front. The frontal system and associated precipitation passed through the MIST/FLOWS network around 1700 GMT. Winds behind the front were shifted ~30° clockwise and were about 2-3 m s^{-1} stronger than winds ahead of the front. Although thermodynamic variations across the frontal zone were subtle, air behind it was stable, as indicated by the suppression of the convective cloud field. Drying immediately behind the front was gradual, being more pronounced 100 km behind the surface frontal position. Winds aloft increased from the westerly direction to ~ 20 m s^{-1} behind the short wave trough whose axis appeared to lay over the surface front. Afternoon values of surface temperature and dewpoint over the SPACE mesonet ranged from 25 and 18 °C over the northwest to 27 and 20 °C over the southeast network. Surface flow was west-northwesterly at ~5 m s^{-1}.

Cloud/Precipitation Overview

Skies were generally overcast from early morning to early afternoon. A 50 km wide patch of intense showers and thunderstorms (tops 6-12 km) were embedded within stratiform rain, located in advance of and along the surface front. Some cells were quite intense, exhibiting reflectivity factors greater than 55 dBZ and maximum echo tops of about 12 km. However, radial velocity patterns were relatively featureless, and cloud-to-ground lightning activity was virtually absent. All activity moved out the Doppler coverage area by 1900 GMT.

Notes:

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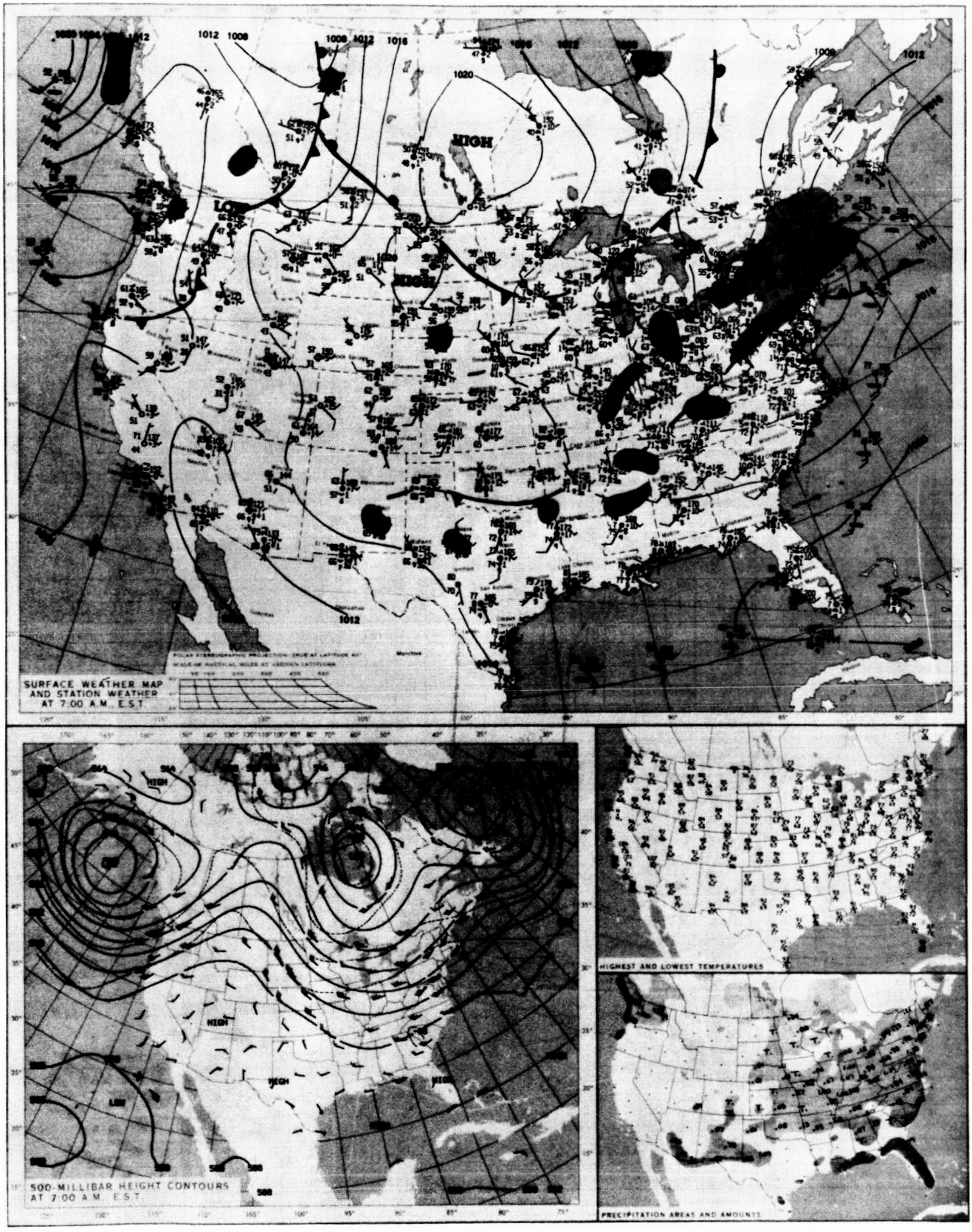


Fig. 3.2-31a. Synoptic weather conditions for 2 July 1986 1200 GMT

OPERATIONAL SUMMARY

2 July 1986

Rawinsonde Operations

A full and highly successful Meso-beta rawinsonde operation was conducted at 3-h intervals from 1500 to 2100 GMT. The front and associated precipitation band moved through the center of the network during this time interval.

Radar Operations

Primarily surveillance and sectored PPI scans were conducted by the NCAR Doppler radars as the front moved through the central portion of the mesonet. A CP-2/CP-3 dual Doppler scan was acquired on a small portion of the cold front from 1630 to 1703 GMT. During the ER-2 mission, CP-2 scanned primarily the area of precipitation being examined by the ER-2. Some VAD scans were completed by CP-4 both ahead of and behind the front. Radar coverage throughout the cold frontal passage time interval appears to be very good.

Satellite Operations

Normal satellite operations were conducted. Most VAS products appear to have been archived through 2130 GMT. However, extensive low level cloudiness was located well in advance of the front.

Aircraft Operations

A precipitation mission by the ER-2 was conducted over the southeast central SPACE mesonet from ~1700 to ~1900 GMT. Target clouds were primarily rain shower and thunderstorm cells located ahead of the front, 10-60 km east of CP-4. Maximum radar reflectivity factor and echo top were 55 dBZ and 10-12 km, respectively. The P-3 conducted a mission during the afternoon hours, but did not locate any precipitating convection within the SPACE area.

Notes:

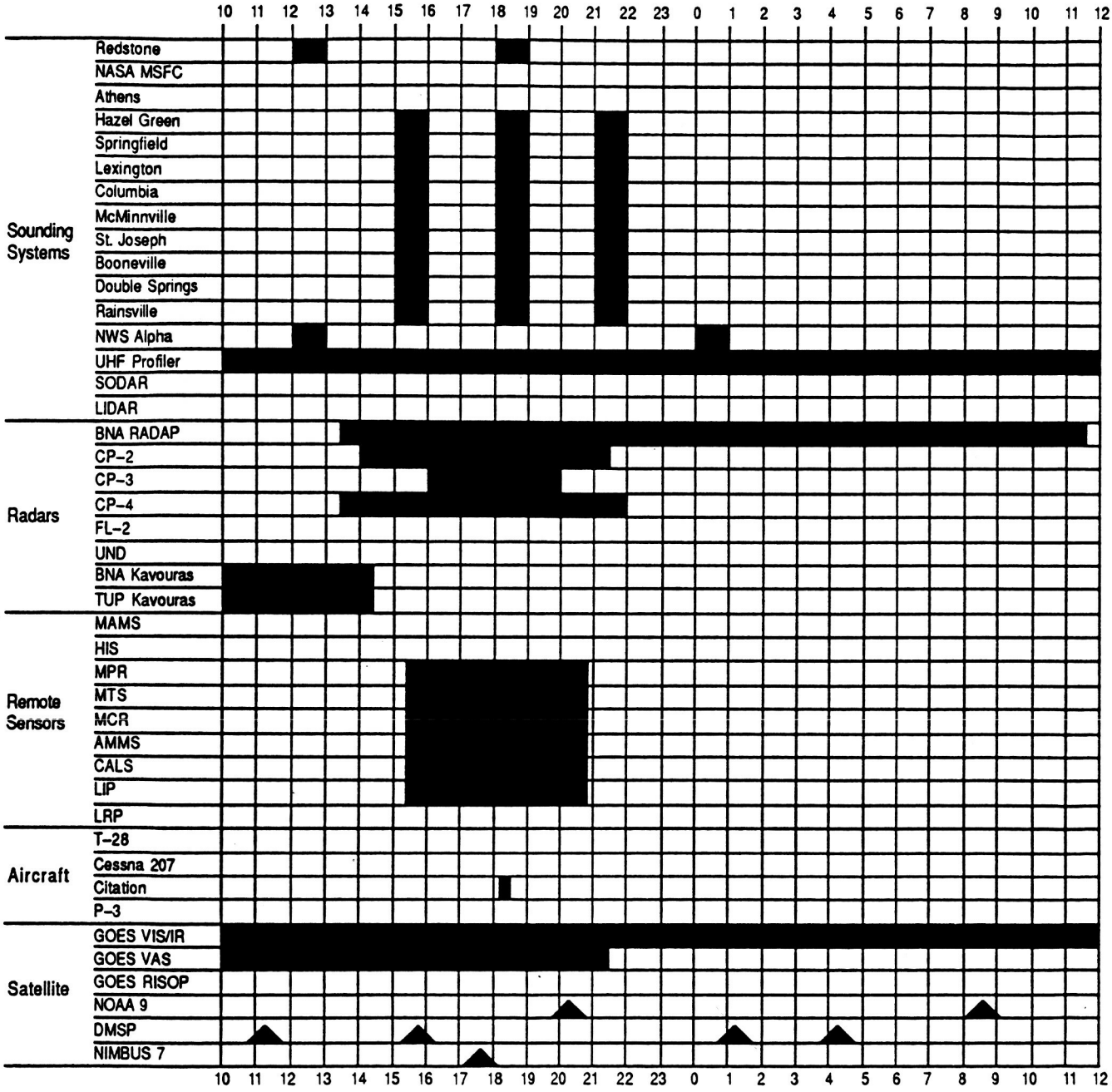
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S-550-7-8(31)

Day: WEDNESDAY
Date: 7/2/86
Julian Day: 183–184

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 5 & 8
	TVA ADAS	MISSING STATIONS 12, 16, 21, 27, 45 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

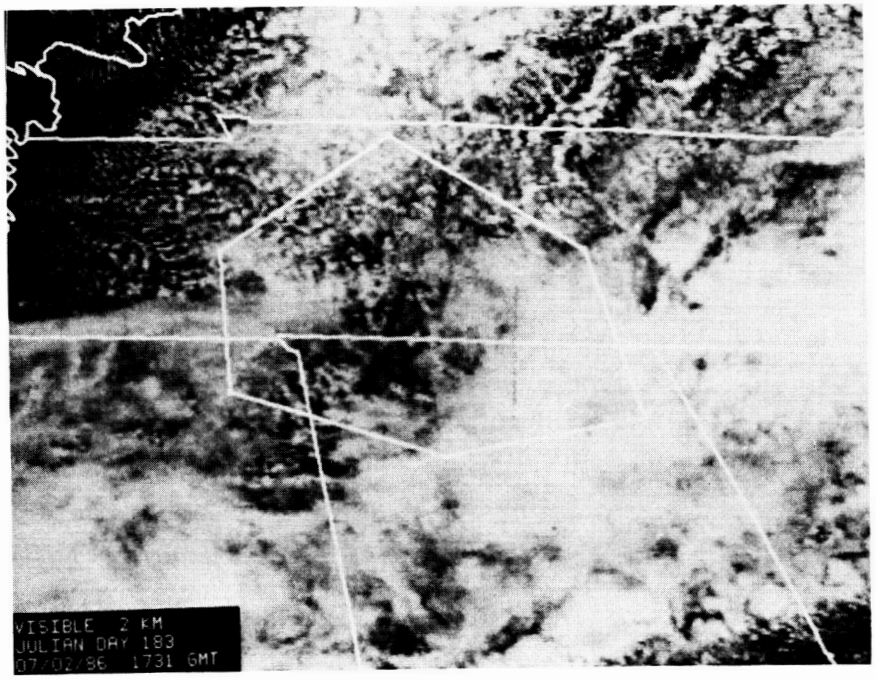


Fig. 3.2-31b. Visible 2 km GOES Central satellite image for 2 July 1986 1731 GMT

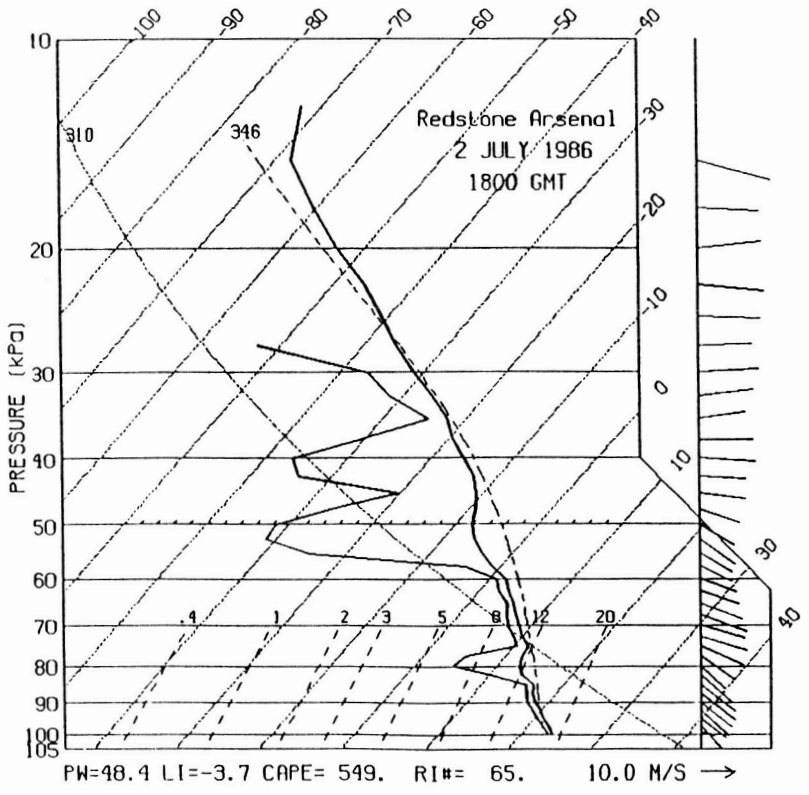


Fig. 3.2-31c. Redstone Arsenal, AL, rawinsonde sounding for 2 July 1986 1800 GMT

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Fig. 3.2-31d. Twenty-four hour lightning strike density plot for 2-3 July 1986

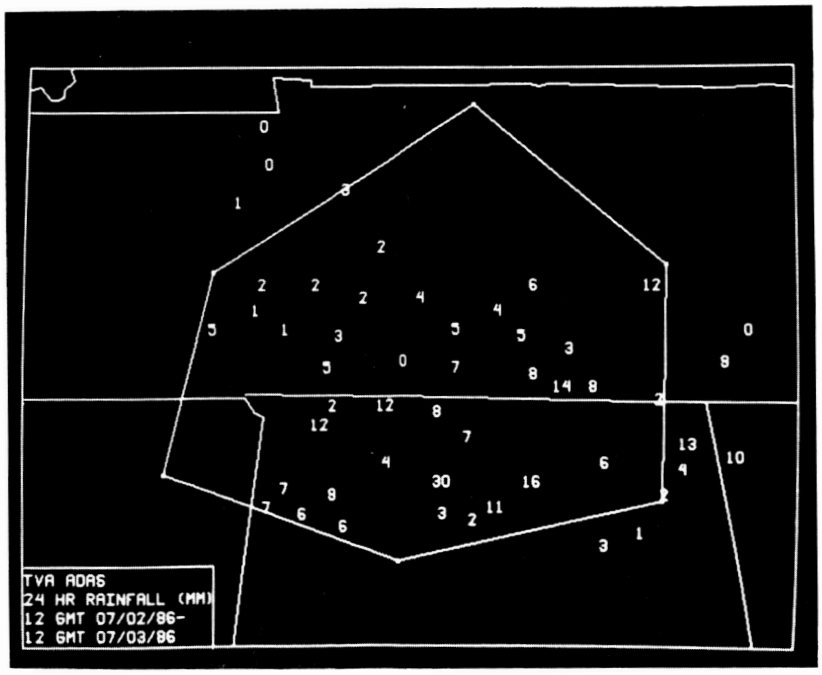


Fig. 3.2-31e. Twenty-four hour TVA ADAS rainfall totals (mm) for 2-3 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

3 July 1986

Synoptic Conditions

A much more stable and drier post-frontal air mass covered the entire mesonet. Negative vorticity advection appeared to influence the mesonet all day as an upper level ridge began to settle over the region. Afternoon values of surface temperature and dewpoint were 28 and 14 °C over the northern mesonet, and 28 and 18 °C over the south. Surface flow was north to northeasterly at 3-4 m s^{-1}.

Cloud/Precipitation Overview

This was a suppressed day, with only cumulus mediocris clouds (~50% cover at maximum) developing from late morning to midafternoon. Clearer conditions existed over the northern SPACE network (where low level air was drier and more stable) than over the southern portion. No precipitation was recorded.

Notes:

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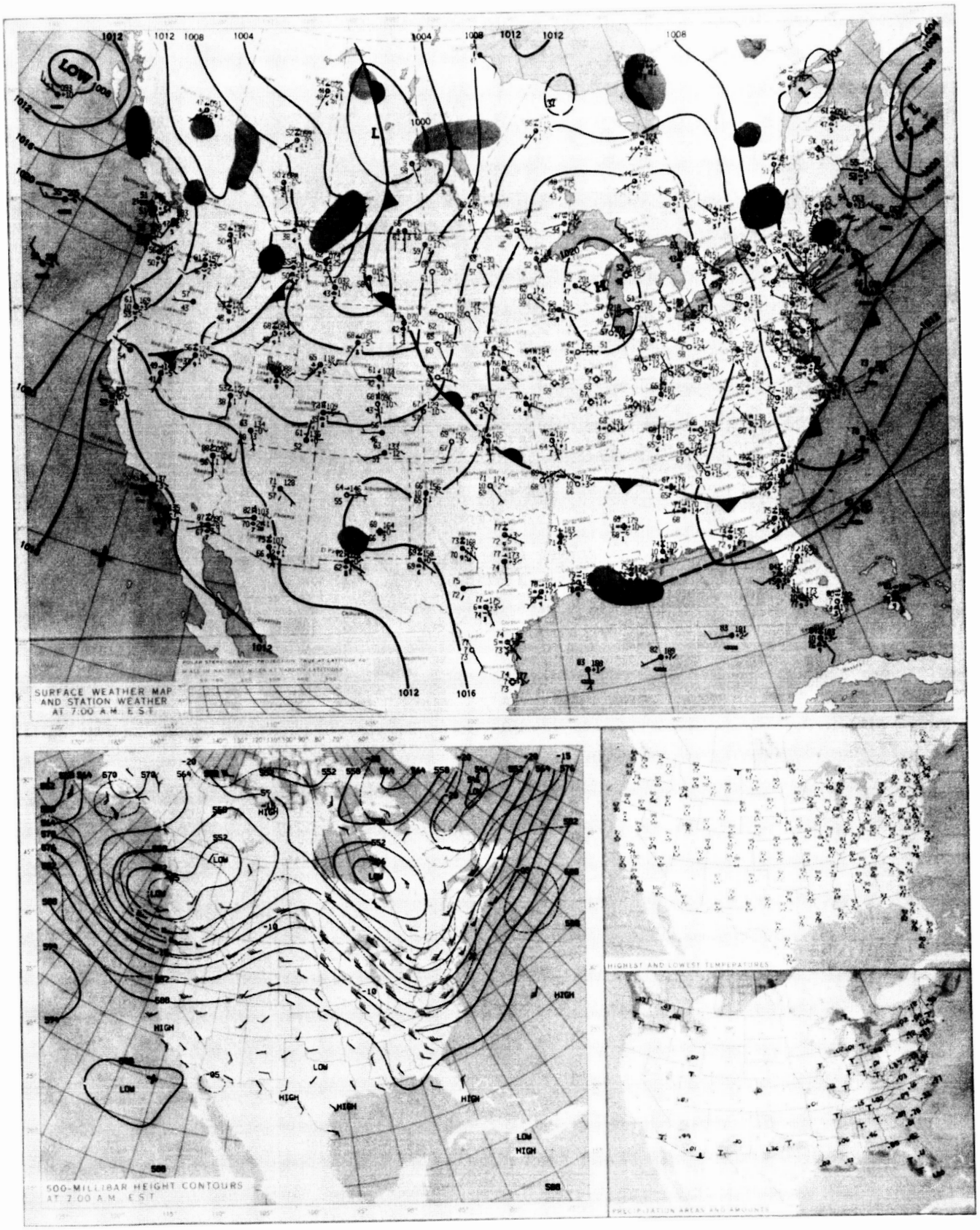


Fig. 3.2-32a. Synoptic weather conditions for 3 July 1986 1200 GMT

OPERATIONAL SUMMARY

3 July 1986

Rawinsonde Operations

A full Meso-beta rawinsonde operation was conducted to support the U-2 and ER-2 missions. Launches were made at 3-h intervals from 1500 to 2100 GMT.

Radar Operations

FL-2, the only operational radar, gathered 1.3-h of clear air (ground clutter) data from ~1830 to ~2000 GMT.

Satellite Operations

Normal GOES satellite operations were conducted. However, UW went down at 1840 GMT (in the middle of the high altitude aircraft missions), so some VAS products may not be readily available.

Aircraft Operations

The U-2 (MAMS, HIS) and ER-2 (AMMS, MTS, LIT, MPR, MCR) flew coordinated sounding flights over the SPACE network from ~1700 to ~2030 GMT. One aircraft lagged the other by about one hour, each flying 4-5 east-west legs, spaced by about 60 km, over the northern two-thirds of the network.

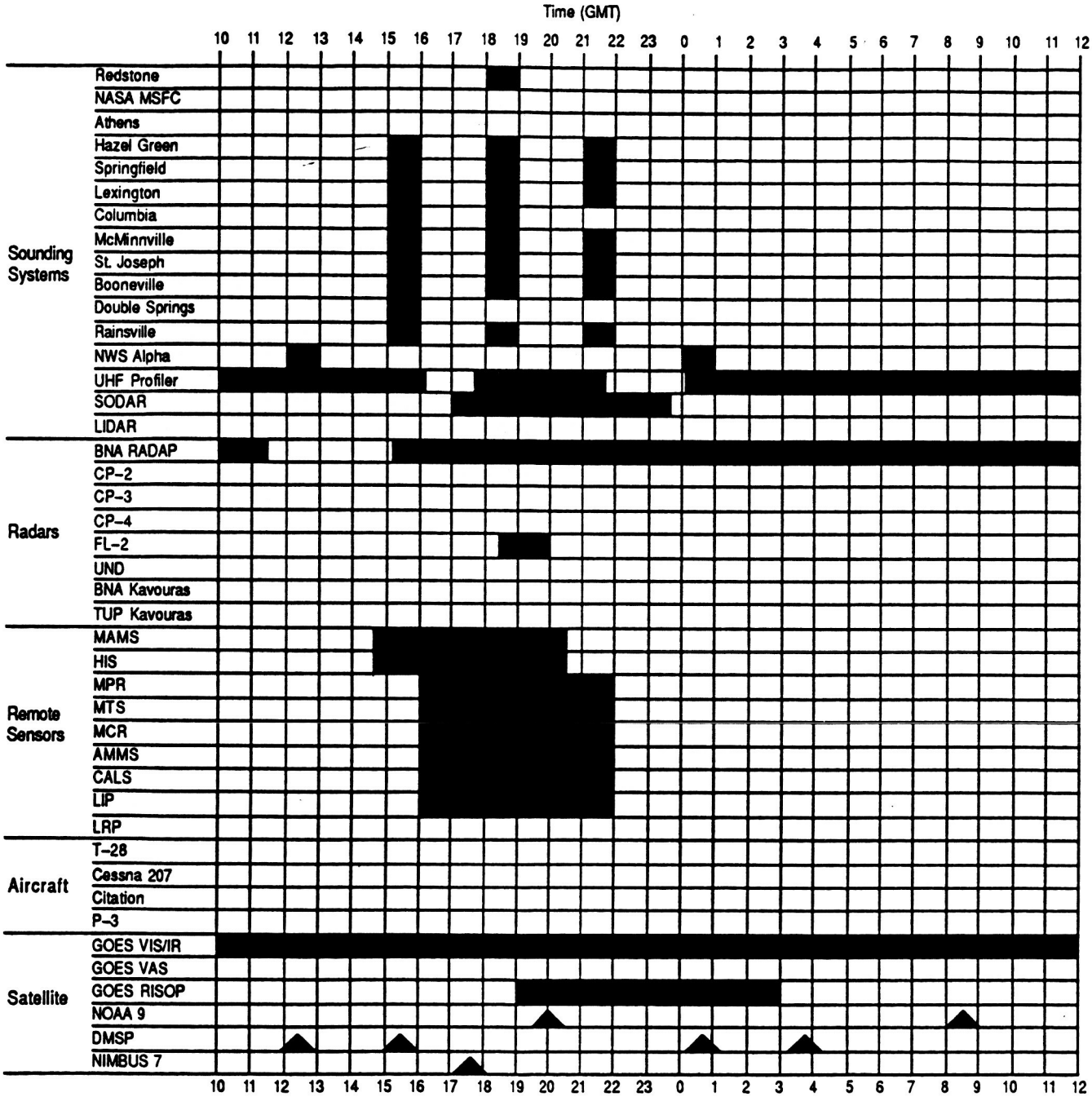
Notes:

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5-550-7-8(32)

Day: THURSDAY
Date: 7/3/86
Julian Day: 184–185

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 5 & 8
	TVA ADAS	ENTIRE DATA SET IS MISSING
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

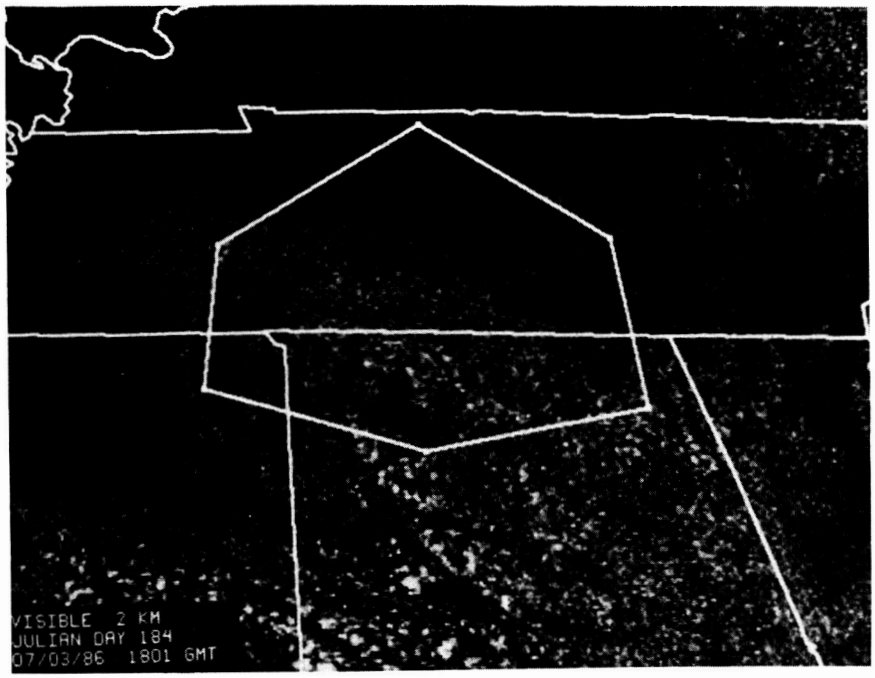


Fig. 3.2-32b. Visible 2 km GOES Central satellite image for 3 July 1986 1801 GMT

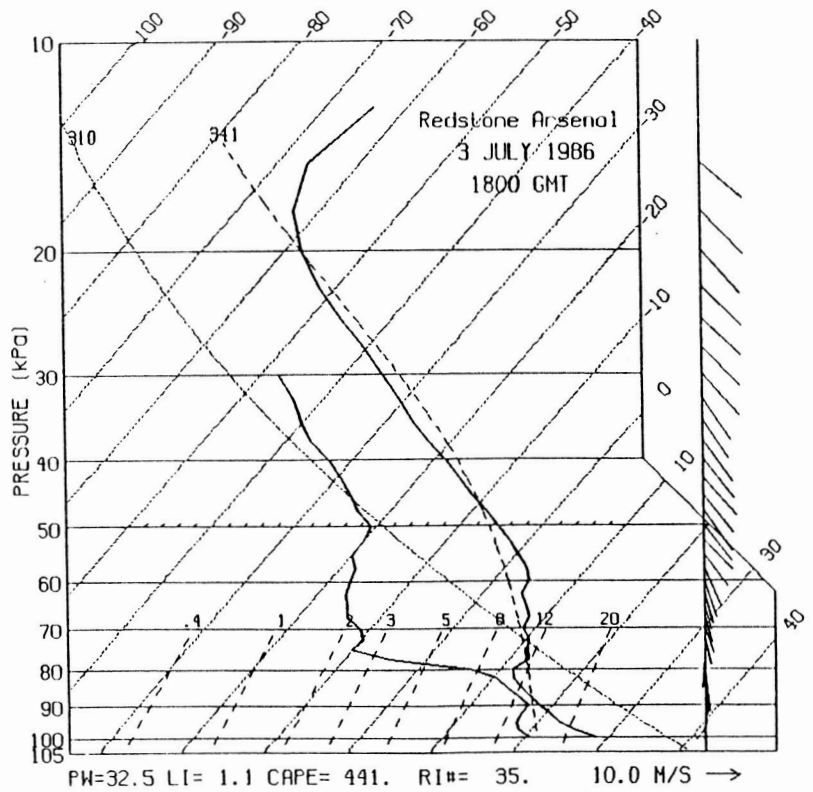


Fig. 3.2-32c. Redstone Arsenal, AL, rawinsonde sounding for 3 July 1986 1800 GMT

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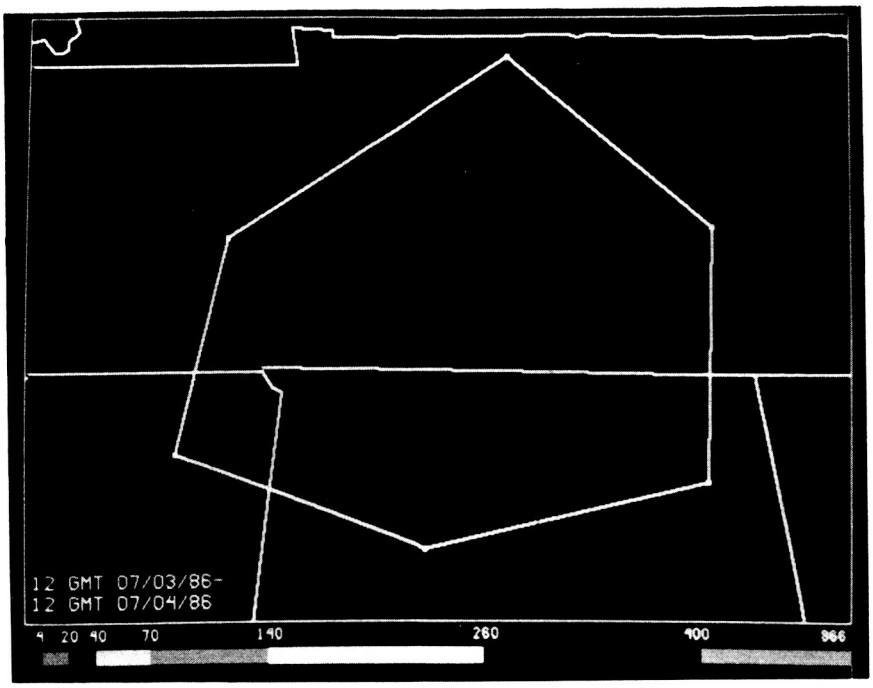


Fig. 3.2-32d. Twenty-four hour lightning strike density plot for 3-4 July 1986

NO ARCHIVE DATA AVAILABLE

Fig. 3.2-32e. Twenty-four hour TVA ADAS rainfall totals (mm) for 3-4 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

4 July 1986

Synoptic Conditions

Upper level ridging combined with continued dry post-frontal air produced another suppressed day over the SPACE mesonet. Winds aloft backed to a more westerly direction and showed a significant decrease in speed from yesterday's values. Afternoon values of surface temperature and dewpoint varied from 30 and 14 °C over the northern mesonet to 30 and 17 °C over the south. Winds were light and variable.

Cloud/Precipitation Overview

The only clouds to form were widely scattered cumulus humilis and cirrus. Closest thunderstorm activity was located over southern Alabama and southern Georgia.

Notes:

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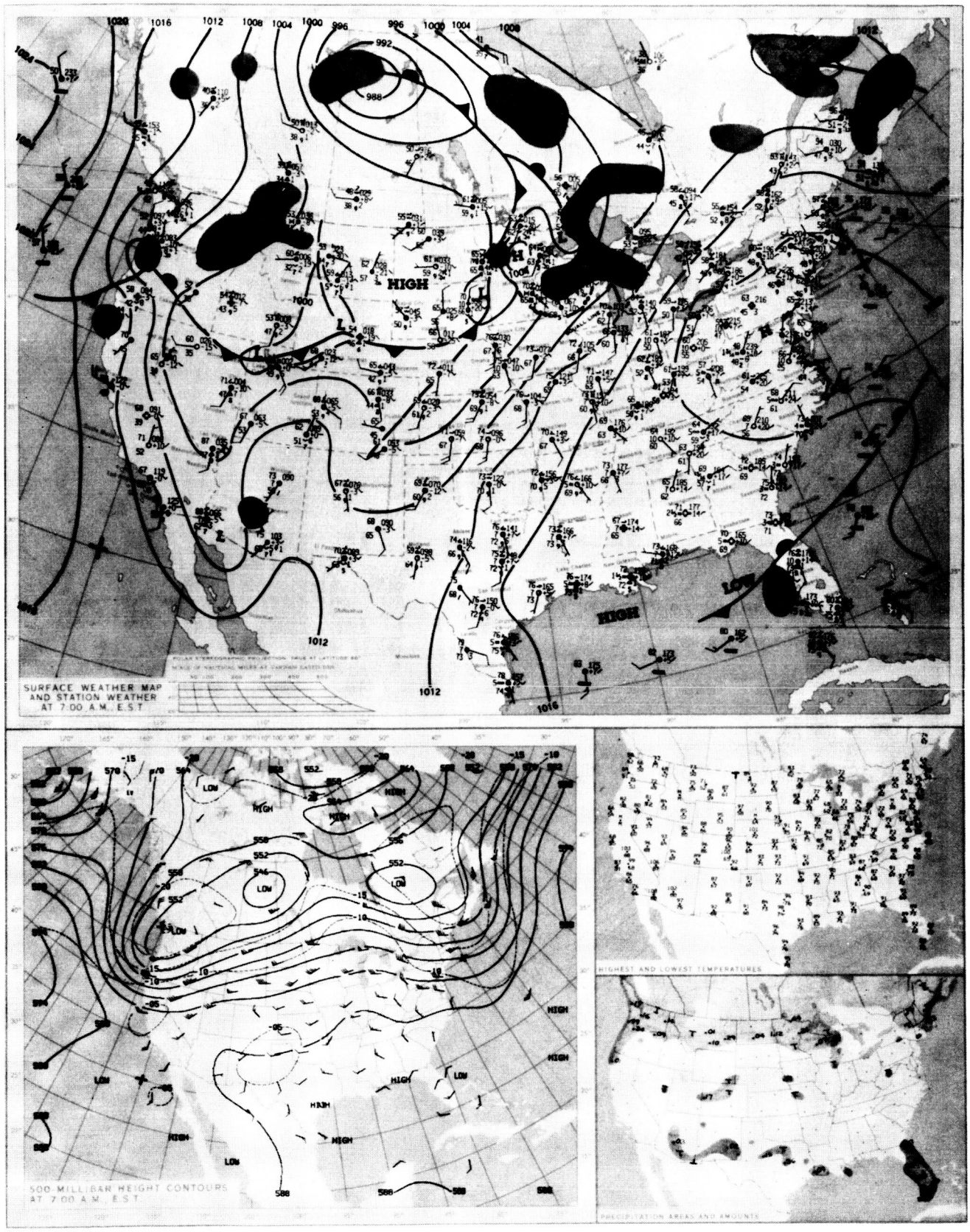


Fig. 3.2-33a. Synoptic weather conditions for 4 July 1986 1200 GMT

OPERATIONAL SUMMARY

4 July 1986

Rawinsonde Operations

No operations.

Radar Operations

No operations.

Satellite Operations

VAS data were not collected because UW was closed for the holiday.

Aircraft Operations

No operations.

Notes:

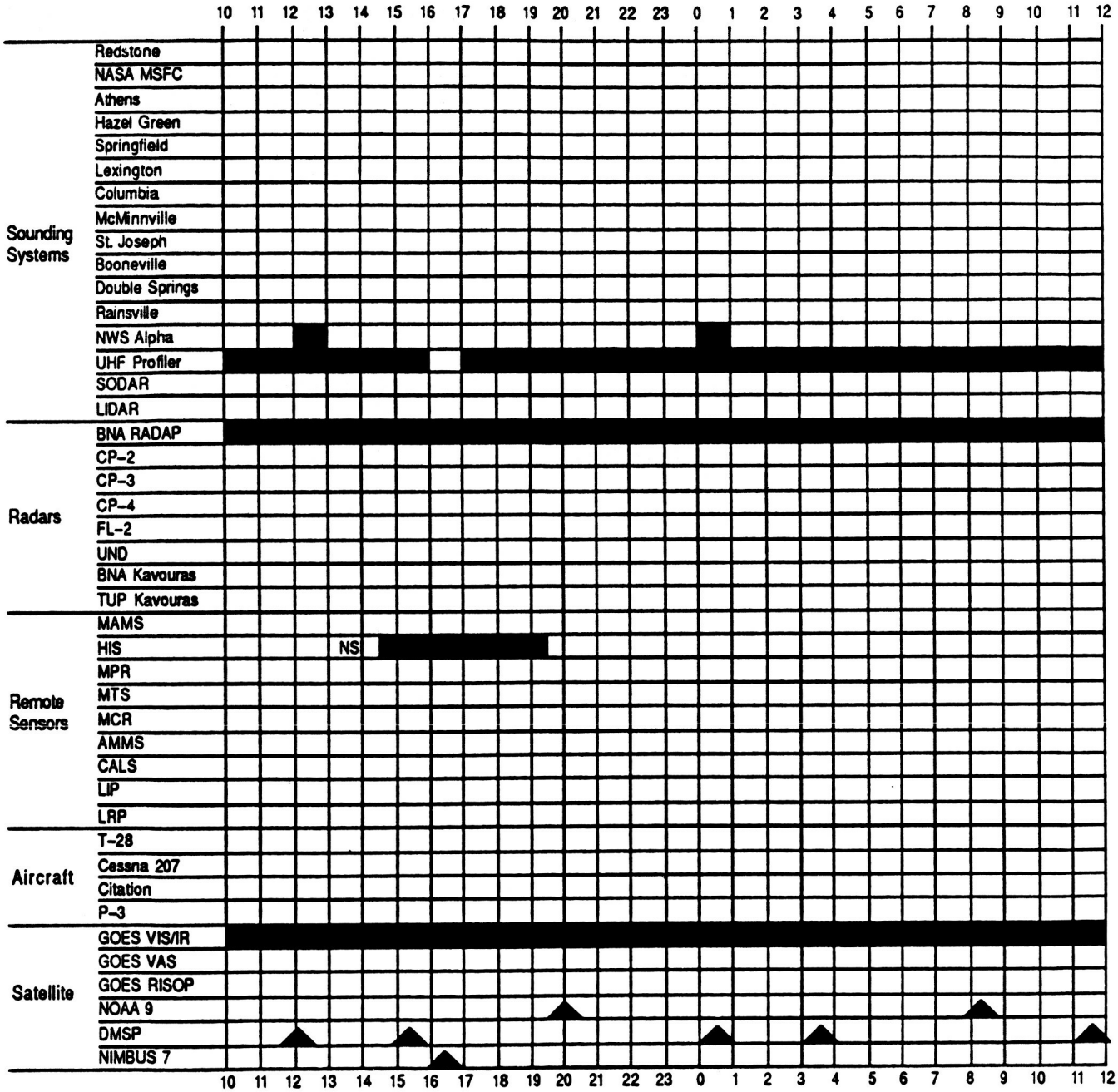
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5-550-7-8(33)

Day: FRIDAY
Date: 7/4/86
Julian Day: 185–186

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 5 & 8
	TVA ADAS	MISSING STATIONS 12, 16, 21, 22, 45 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL



Fig. 3.2-33b. Visible 2 km GOES Central satellite image for 4 July 1986 1901 GMT

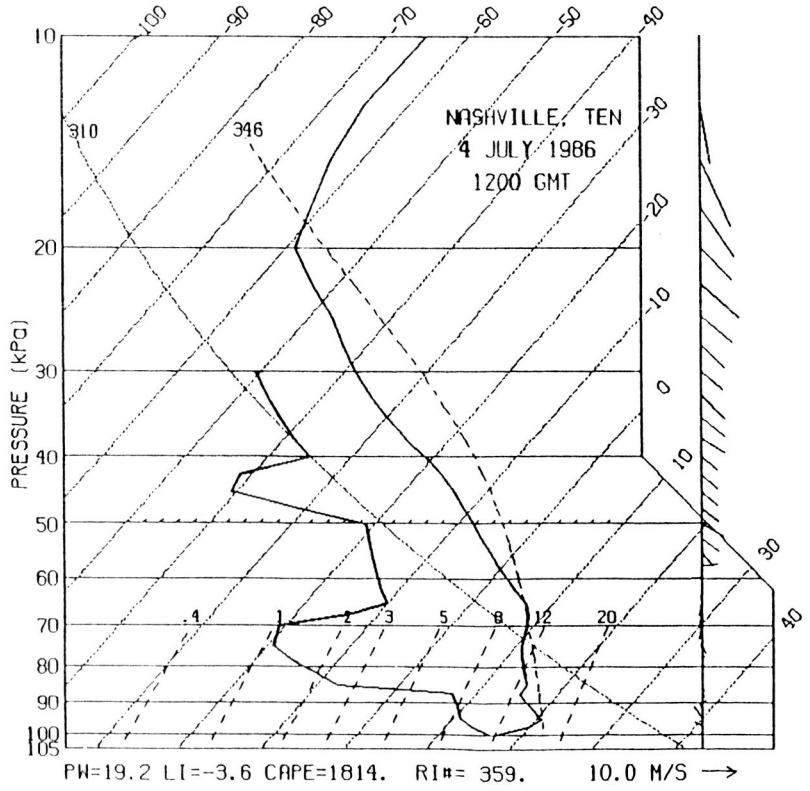


Fig. 3.2-33c. Nashville, TN, rawinsonde sounding for 4 July 1986 1200 GMT

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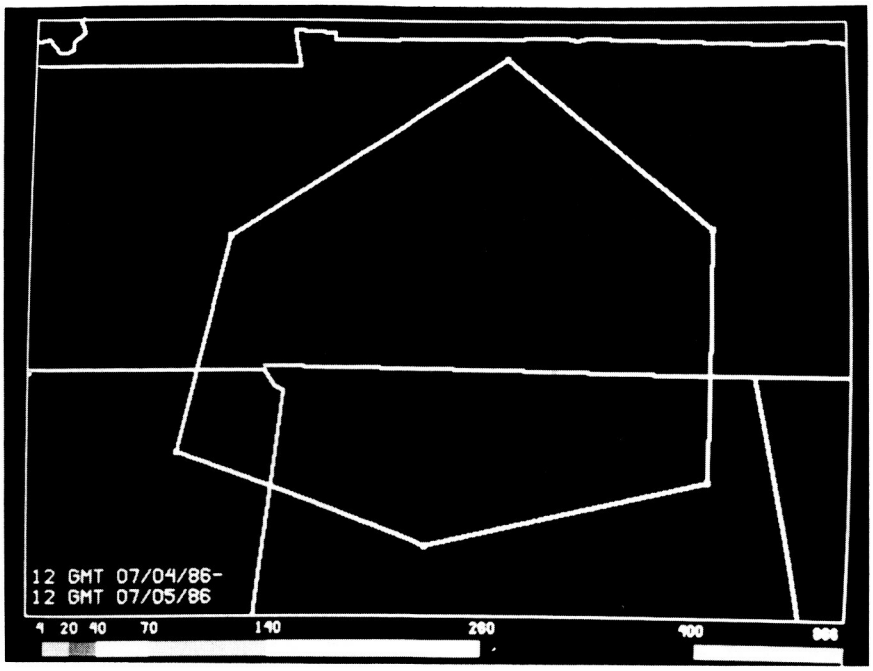


Fig. 3.2-33d. Twenty-four hour lightning strike density plot for 4-5 July 1986

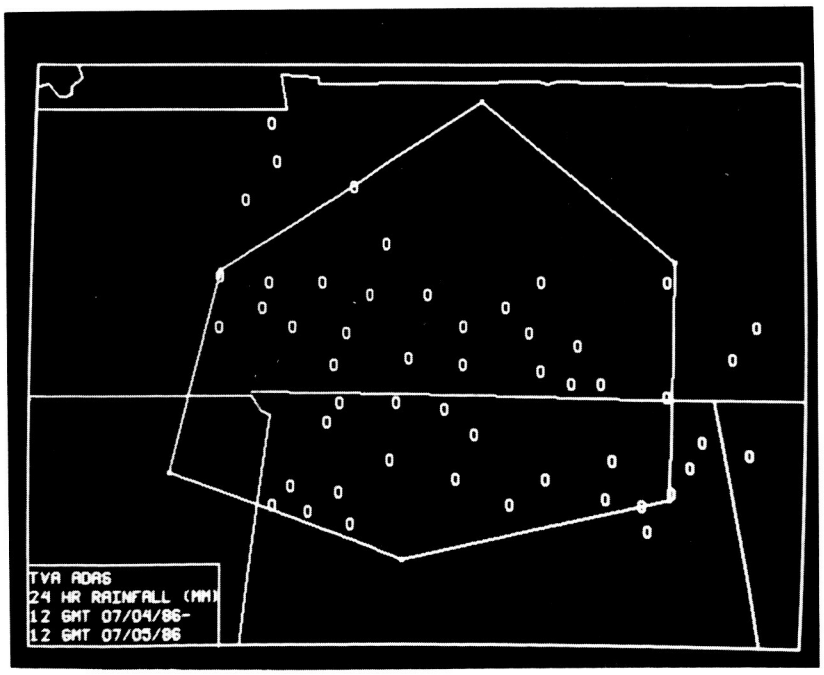


Fig. 3.2-33e. Twenty-four hour TVA ADAS rainfall totals (mm) for 4-5 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

5 July 1986

Synoptic Conditions

A deep subtropical high, exhibiting a cutoff circulation center just off the Carolina coast, continued to amplify over the Southeast. Winds over the SPACE region remained very light and variable. Low level static stability increased from yesterday, and precipitable water values over the region remained below average. At the surface, afternoon temperature and dewpoint values over the SPACE mesonet were more uniform at 32 °C and 18-20 °C, respectively.

Cloud/Precipitation Overview

Convective clouds over the Meso-beta network formed around 1700 GMT and remained widely scattered over the Meso-beta network during the afternoon hours. Individual cumuli were generally small (primarily congestus at most) and short-lived. Some appeared to have been aggregated into clusters or lines having a general north-south orientation. A few cumuli achieved a weakly precipitating stature, but precipitation amounts were small and the events were isolated.

Notes:

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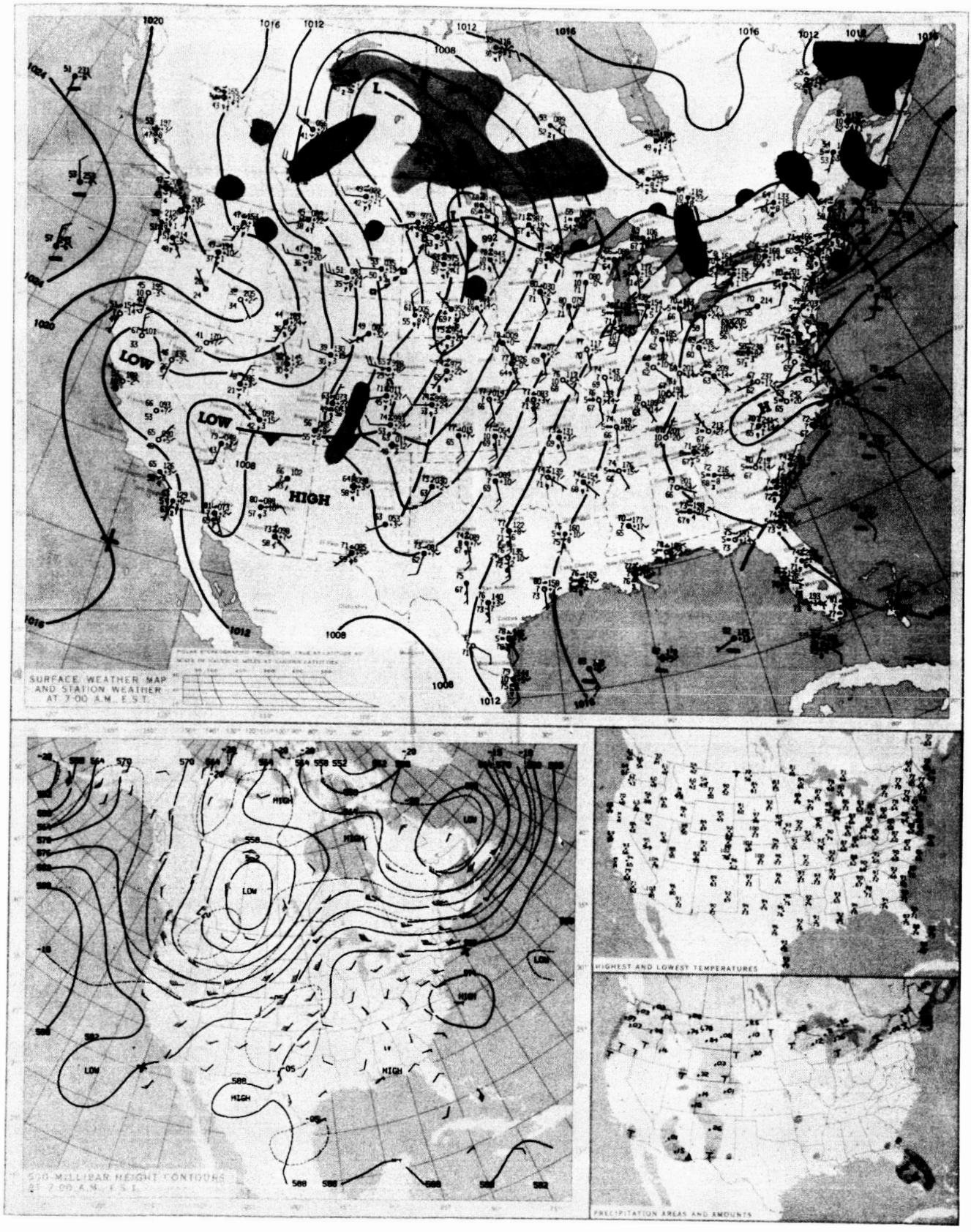


Fig. 3.2-34a. Synoptic weather conditions for 5 July 1986 1200 GMT

OPERATIONAL SUMMARY

5 July 1986

Rawinsonde Operations

The 1200 GMT RSA sounding represents the only special sounding taken within the mesonet.

Radar Operations

No operations.

Satellite Operations

Normal operations.

Aircraft Operations

No operations.

Notes:

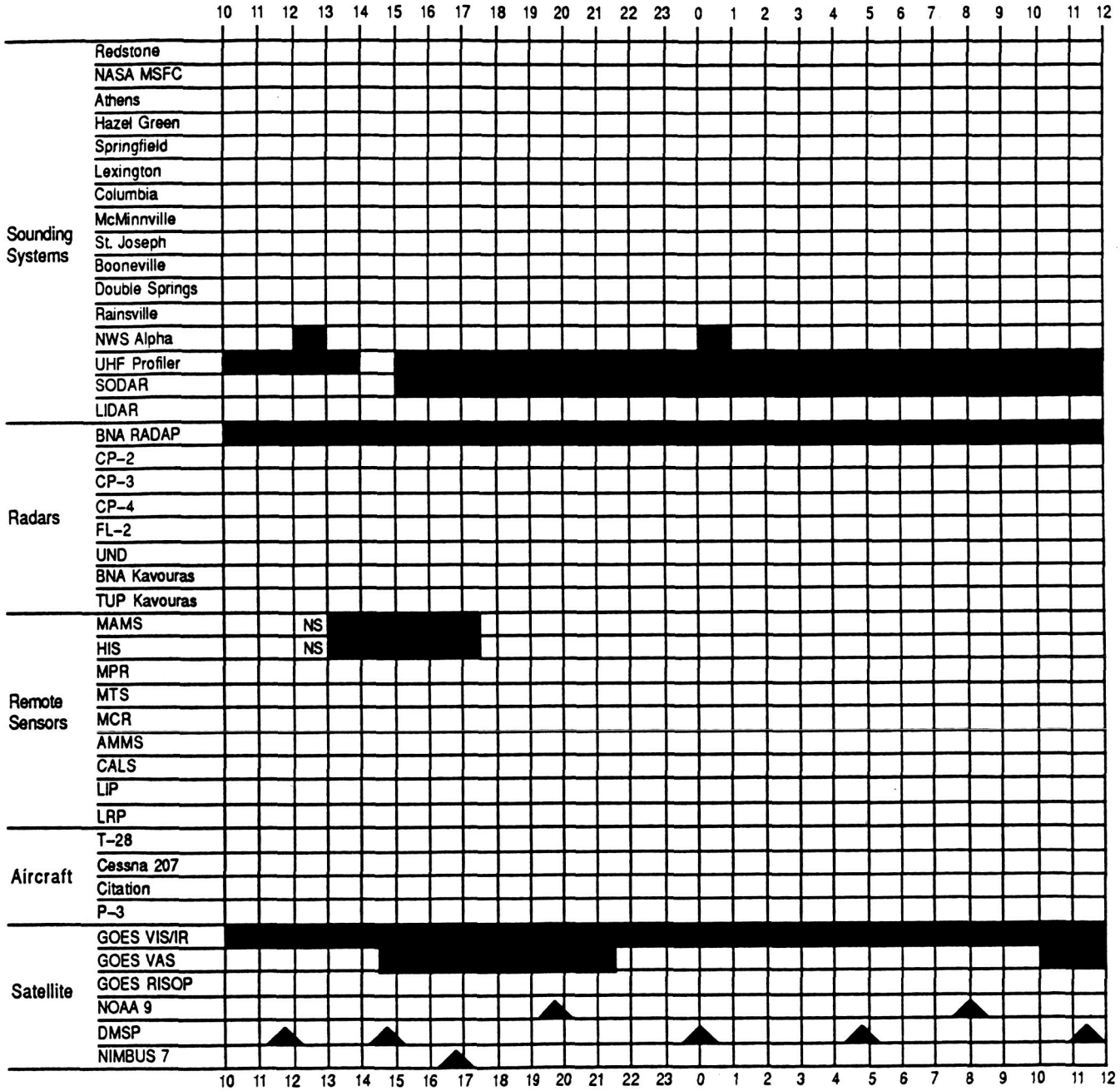
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5-550-7-8(34)

Day: SATURDAY
Date: 7/5/86
Julian Day: 186–187

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 5, 8 & 9
	TVA ADAS	MISSING STATIONS 3, 4, 12, 14, 16, 21, 22, 45 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

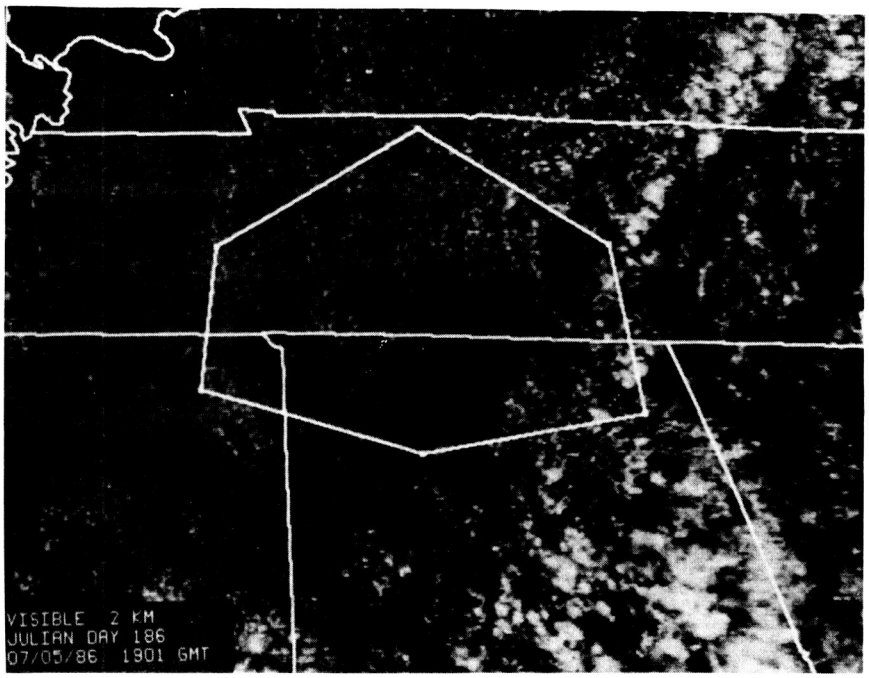


Fig. 3.2-34b. Visible 2 km GOES Central satellite image for 5 July 1986 1901 GMT

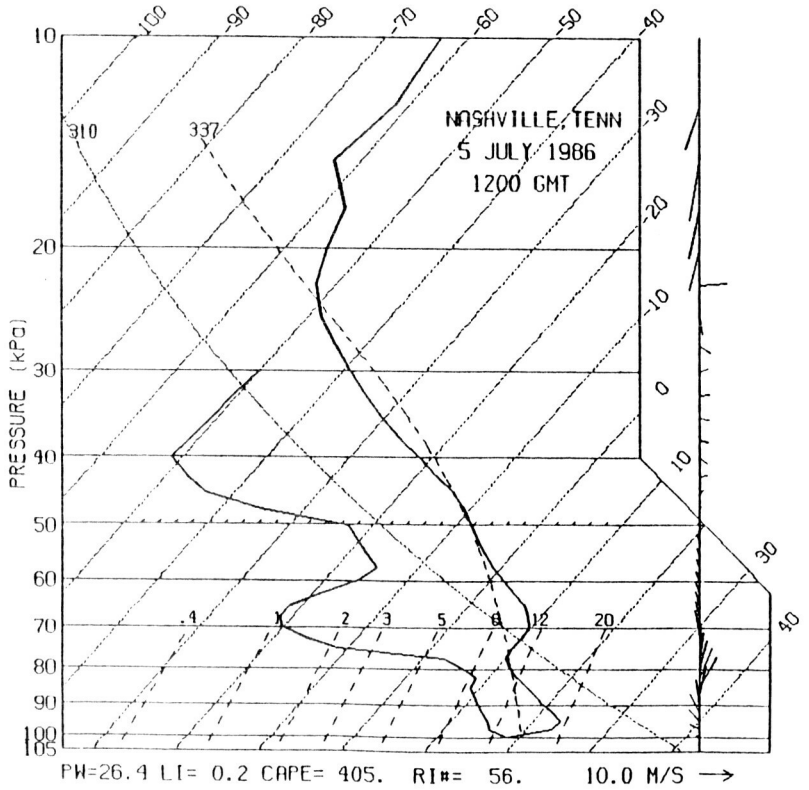


Fig. 3.2-34c. Nashville, TN, rawinsonde sounding for 5 July 1986 1200 GMT

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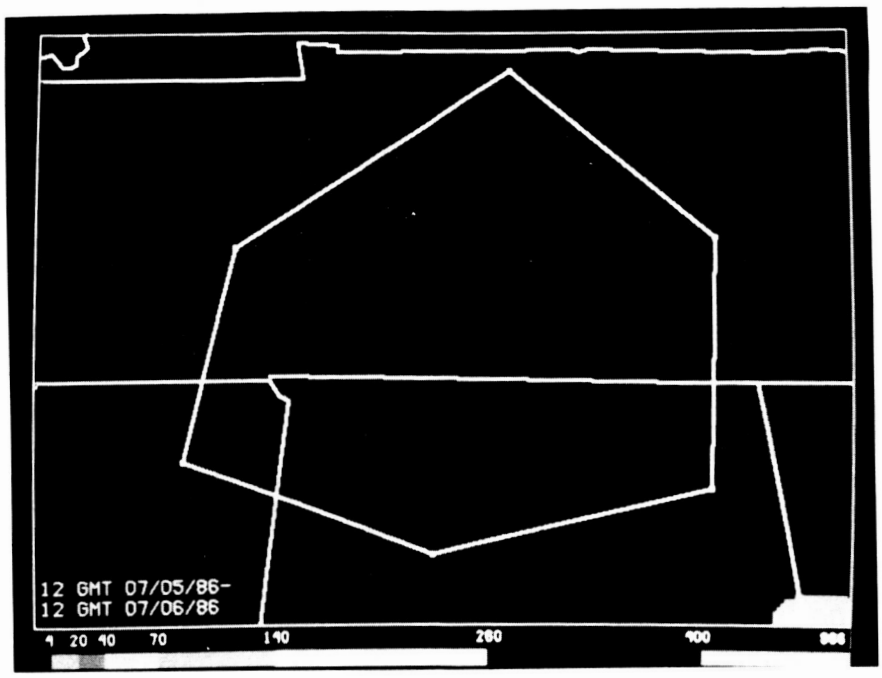


Fig. 3.2-34d. Twenty-four hour lightning strike density plot for 5-6 July 1986

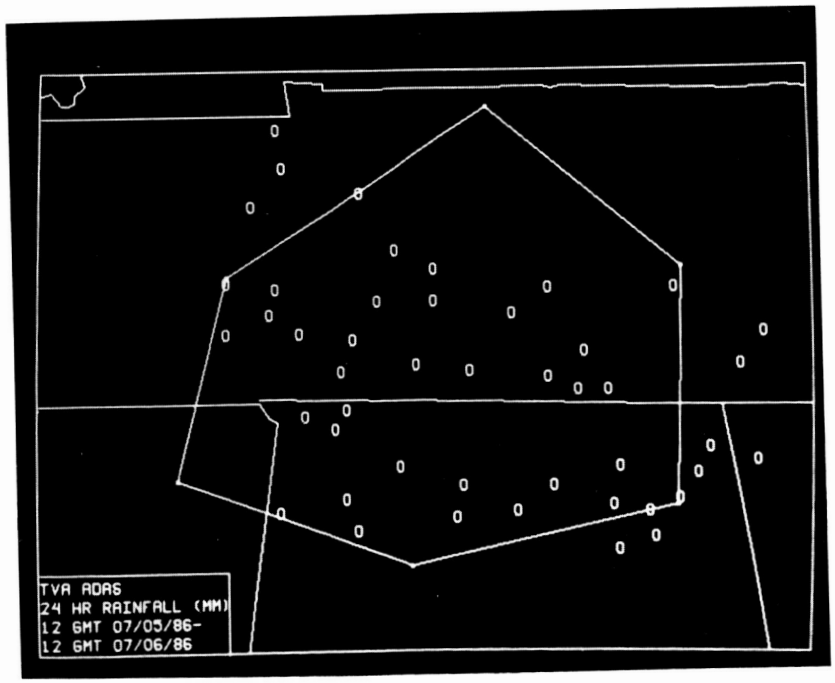


Fig. 3.2-34e. Twenty-four hour TVA ADAS rainfall totals (mm) for 5-6 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

6 July 1986

Synoptic Conditions

The upper level cutoff ridge continued to amplify off the Carolina coast. In response, flow was generally east to southeasterly at 5-10 m s^{-1} throughout the troposphere. The 1800 GMT RSA sounding indicated a more unstable atmosphere as greater low level moisture moved into the southern SPACE mesonet. The early morning 6.7 micrometer water vapor image indicated greatest middle level moisture over the Alabama-Georgia border. At the surface, the southern SPACE mesonet was cooler and more moist (temperature and dewpoint values of 31 and 21 °C), while the northern mesonet was warmer and drier (temperature and dewpoint values of 34 and 17 °C). Surface flow was light (2-3 m s^{-1}) from the south.

Cloud/Precipitation Overview

First cumulus clouds were observed in the HSV region near 1630 GMT. Convective clouds continued to strengthen thereafter, reaching peak intensity and coverage by 2000 GMT. Afternoon thunderstorm activity was scattered over north Alabama and central Tennessee. Vigorous outflow winds were generally associated with the more intense precipitating cells. Intense thunderstorms developed over HSV (east of the MIST/FLOWS network, but within multiple Doppler coverage) around 1900-2000 GMT. Two individual complexes exhibited tops greater than 13 km and reflectivity factors approaching 70 dBZ. Subsequent convective activity developed over the MIST/FLOWS network along a westward propagating gust front generated by the earlier thunderstorms over HSV.

FL-2 radar personnel logged five microbursts between 2015 and 2100 GMT. At least two storms displayed low level divergent radial velocity differentials of 24 m s^{-1}.

Notes:

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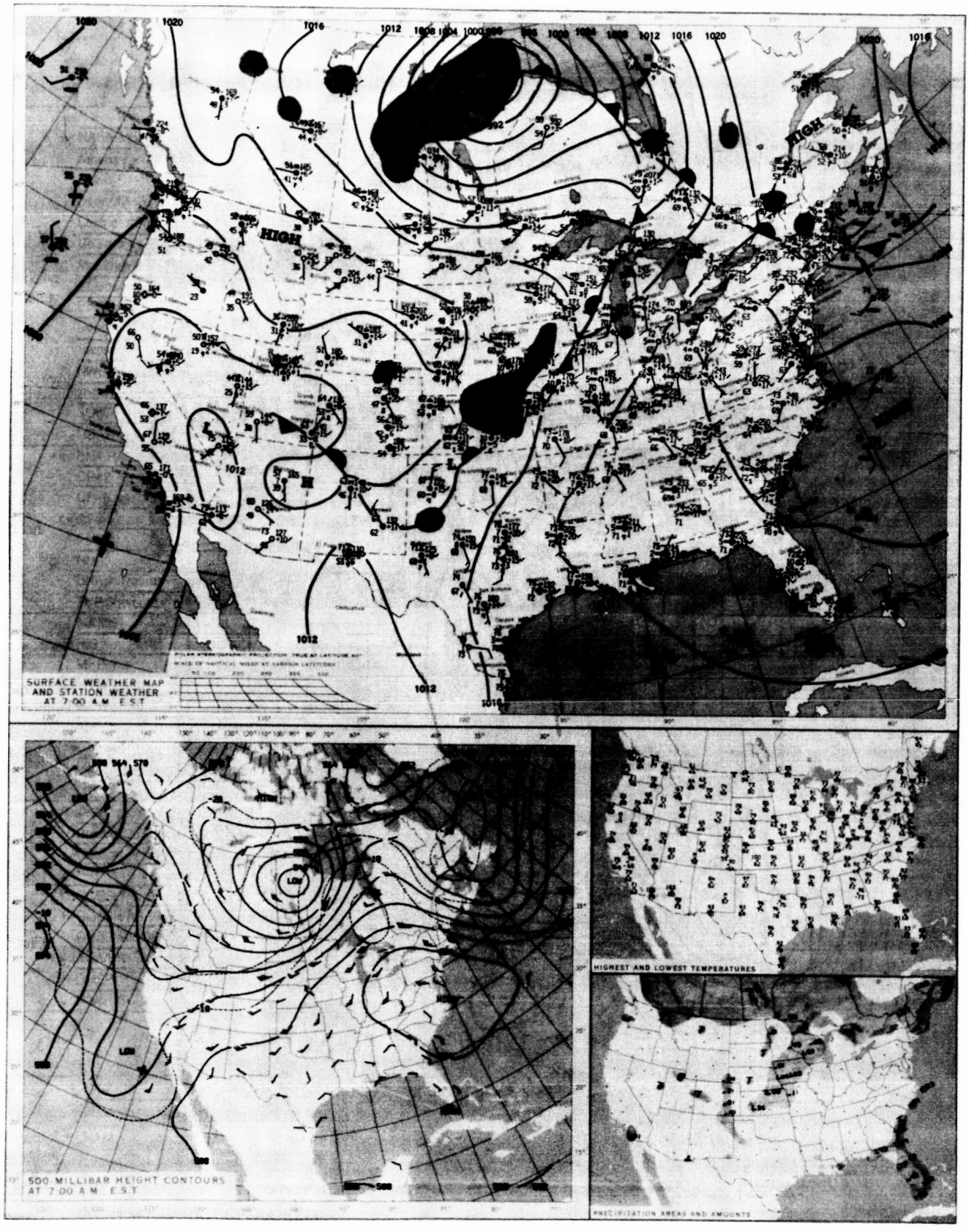


Fig. 3.2-35a. Synoptic weather conditions for 6 July 1986 1200 GMT

OPERATIONAL SUMMARY

6 July 1986

Rawinsonde Operations

The normal special RSA soundings were made at 1200 and 1800 GMT. The latter sounding is close in space and time to the location of subsequent thunderstorm development over HSV.

Radar Operations

The Doppler radars closely examined the intense thunderstorm activity over HSV. Coordinated multiple Doppler scans conducted primarily over the east lobe should portray the evolution of intense thunderstorms as well as the subsequent gust front and associated secondary convection.

Satellite Operations

Normal satellite operations were in effect. VAS products were generated through 2130 GMT.

Aircraft Operations

The Citation initially flew box patterns around an active cumulonimbus cloud system over HSV, and later accomplished successive penetrations of a westward advancing low level gust front generated by the intense HSV thunderstorms.

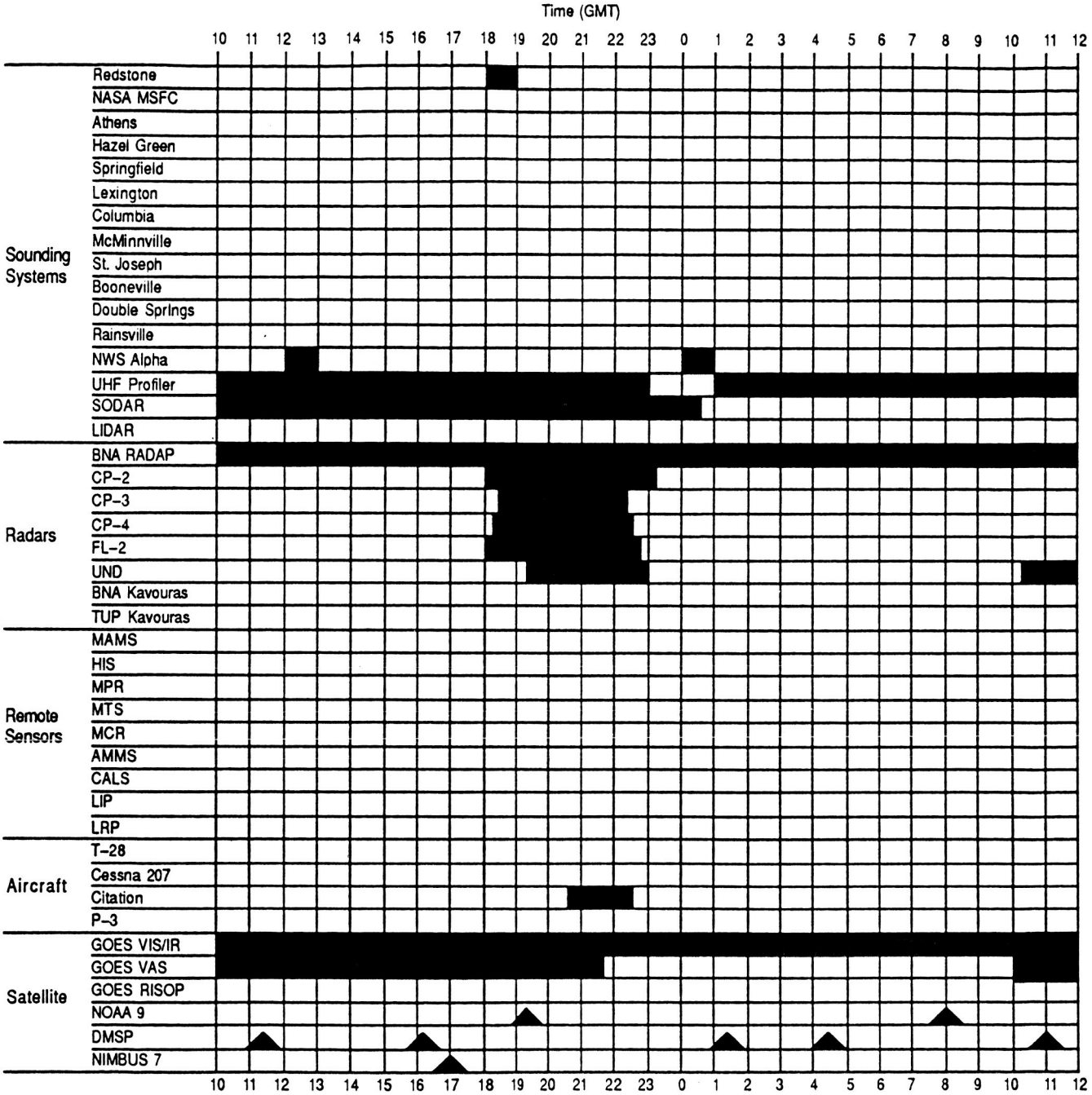
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5-550-7-8(35)

Day: SUNDAY
Date: 7/6/86
Julian Day: 187–188

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4, 5, 8 & 9
	TVA ADAS	MISSING STATIONS 3, 4, 12, 14, 16, 21, 22, 45 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

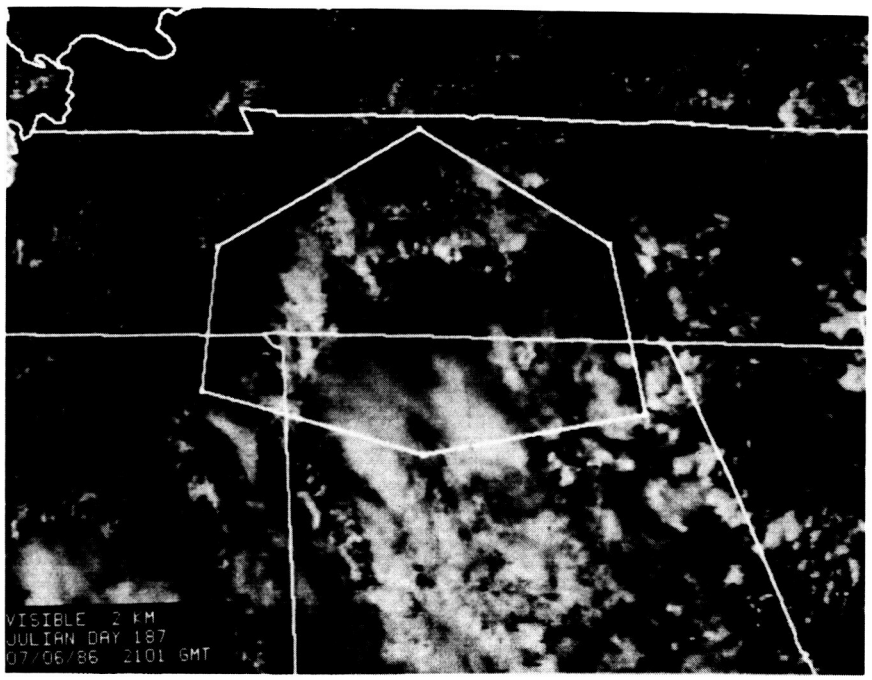


Fig. 3.2-35b. Visible 2 km GOES Central satellite image for 6 July 1986 2101 GMT

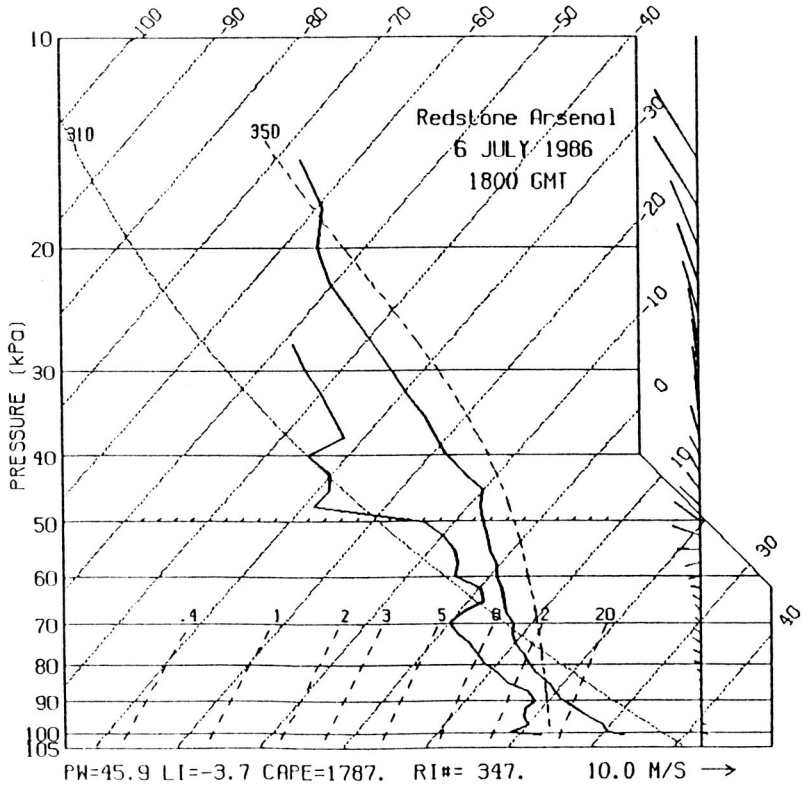


Fig. 3.2-35c. Redstone Arsenal, AL, rawinsonde sounding for 6 July 1986 1800 GMT

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Fig. 3.2-35d. Twenty-four hour lightning strike density plot for 6-7 July 1986

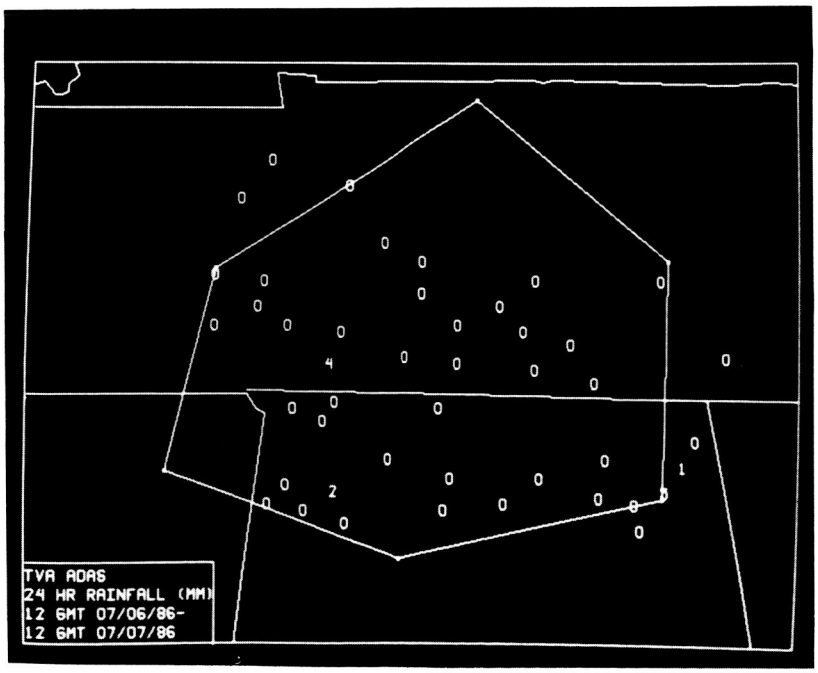


Fig. 3.2-35e. Twenty-four hour TVA ADAS rainfall totals (mm) for 6-7 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

7 July 1986

Synoptic Conditions

A broad subtropical ridge continued to build westward over the SPACE mesonet. Temperatures showed significant warming at middle levels, having increased by 2-3 °C over yesterday's values. The soundings consequently showed greater stability over the region. Winds speeds also decreased at lower to middle levels. Afternoon surface temperature and dewpoint values over the SPACE mesonet ranged from 34 and 19 °C over the northeast border to 32 and 21 °C over the southwest. Surface flow was light and variable.

Cloud/Precipitation Overview

First cloud formation and first echoes appeared near 1730 and 1800 GMT, respectively, which was later than yesterday. Echoes were relatively numerous over the SPACE mesonet and into northern Tennessee, but were in general small and weak. A few echoes exhibited intensities greater than 55 dBZ despite low maximum tops of 8 - 9 km AGL. One small multicellular echo located at 140° at 75 km from CP-4 formed, split, and then exhibited a highly multicellular appearance for the ensuing 1-h period before dissipating. This was the only echo within the SPACE network to produce lightning. Rainfall was absent over the MIST/FLOWS network and only isolated and light over the SPACE network.

Notes:

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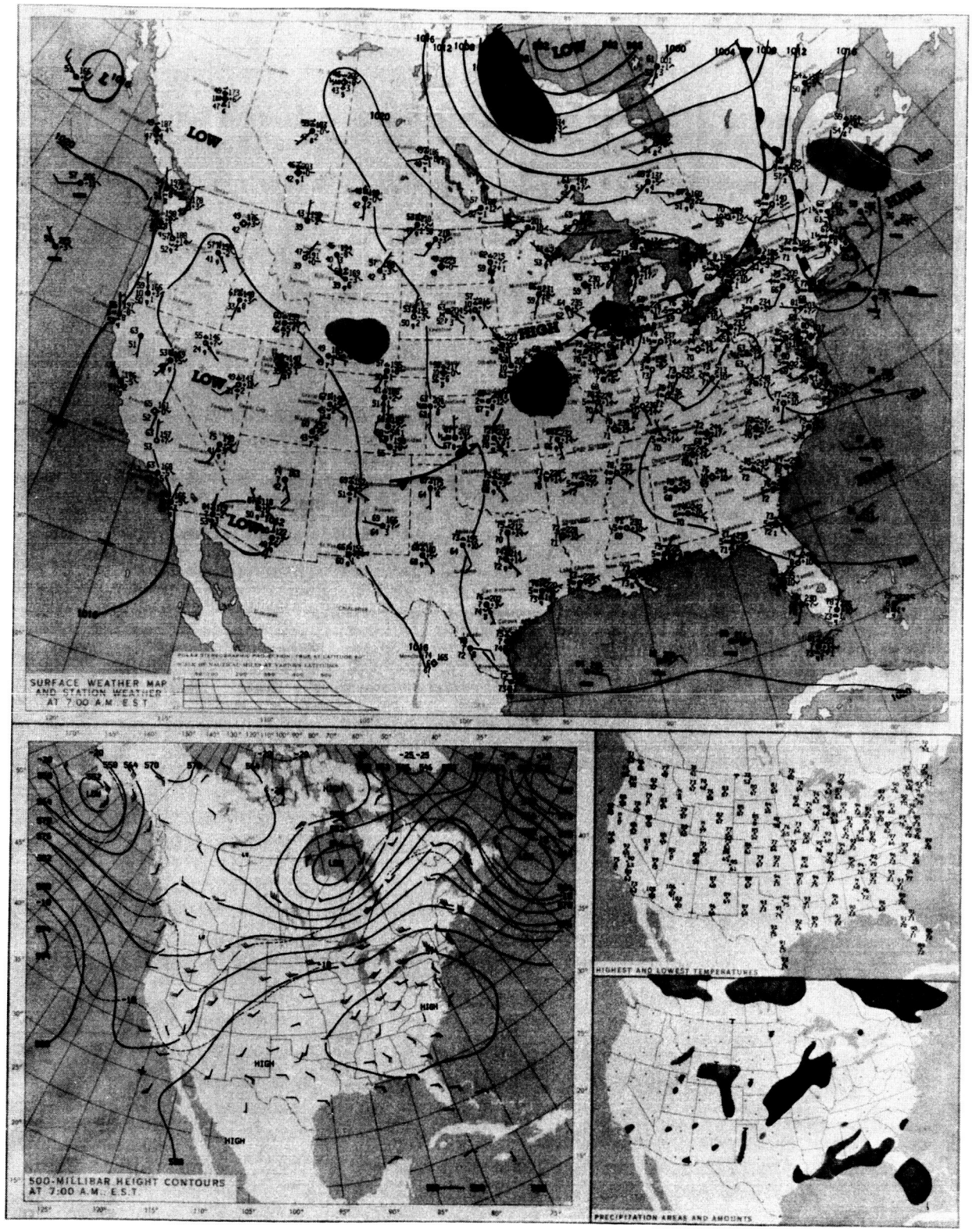


Fig. 3.2-36a. Synoptic weather conditions for 7 July 1986 1200 GMT

OPERATIONAL SUMMARY

7 July 1986

Rawinsonde Operations

Serial soundings were taken from RSA at 1200, 1800, and 2100 GMT.

Radar Operations

CP-4 acted as the primary data collection radar (CP-2 had problems until 2100 GMT) and collected primarily surveillance scan data between 0 and 5°. A few RHI scans were made to examine PBL structure.

Satellite Operations

Normal satellite operations were performed. All VAS products were acquired and archived by UW.

Aircraft Operations

The ER-2 attempted a lightning mission over the SPACE region, but precipitation targets over the SPACE region were absent and limited research work was conducted on thunderstorms located along the Gulf Coast.

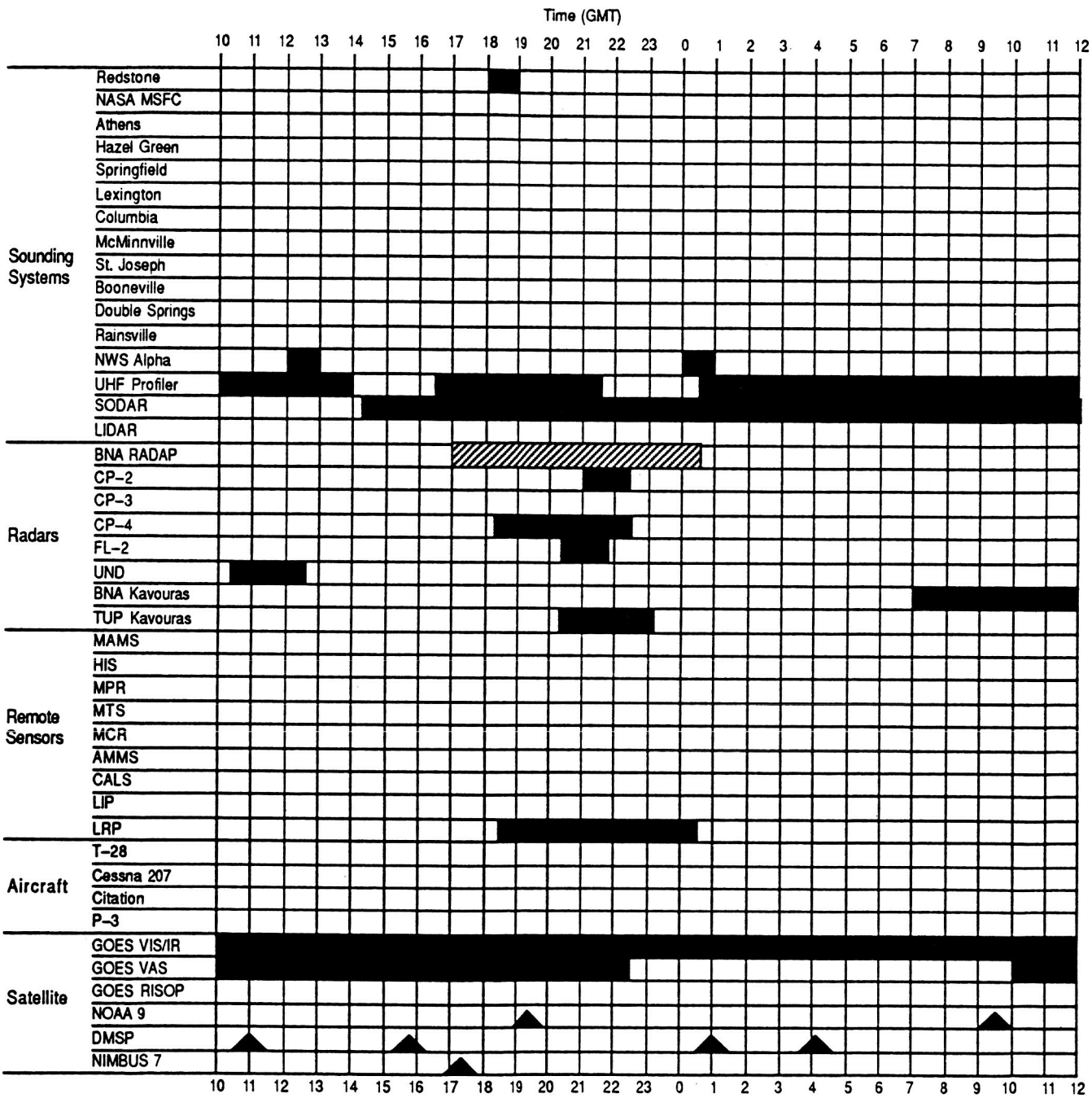
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5-550-7-8(36)

Day: MONDAY
Date: 7/7/86
Julian Day: 188–189

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 5 & 9
	TVA ADAS	MISSING STATIONS 12, 16, 21, 45 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

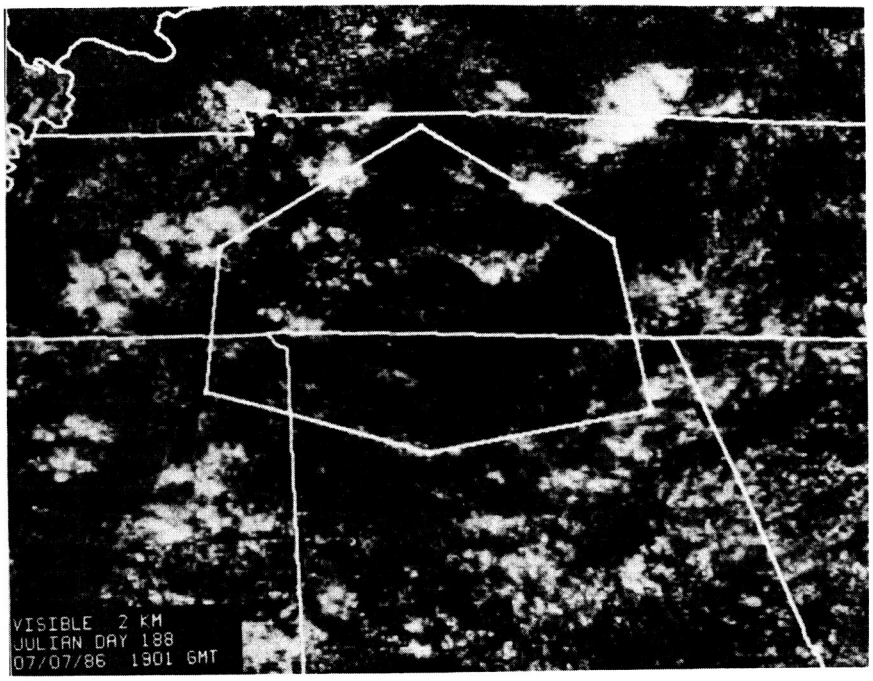


Fig. 3.2-36b. Visible 2 km GOES Central satellite image for 7 July 1986 1901 GMT

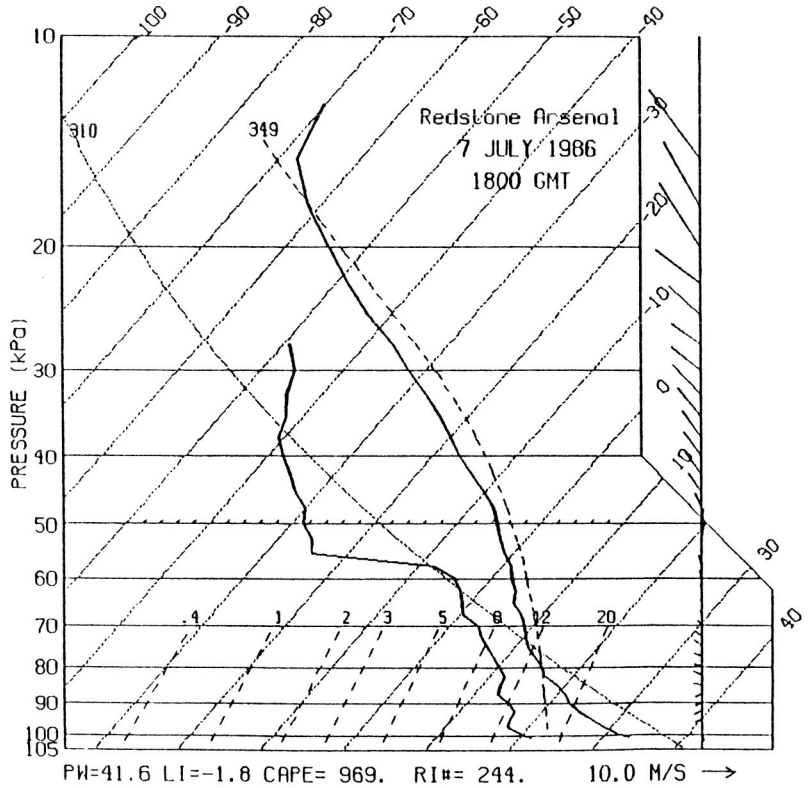


Fig. 3.2-36c. Redstone Arsenal, AL, rawinsonde sounding for 7 July 1986 1800 GMT

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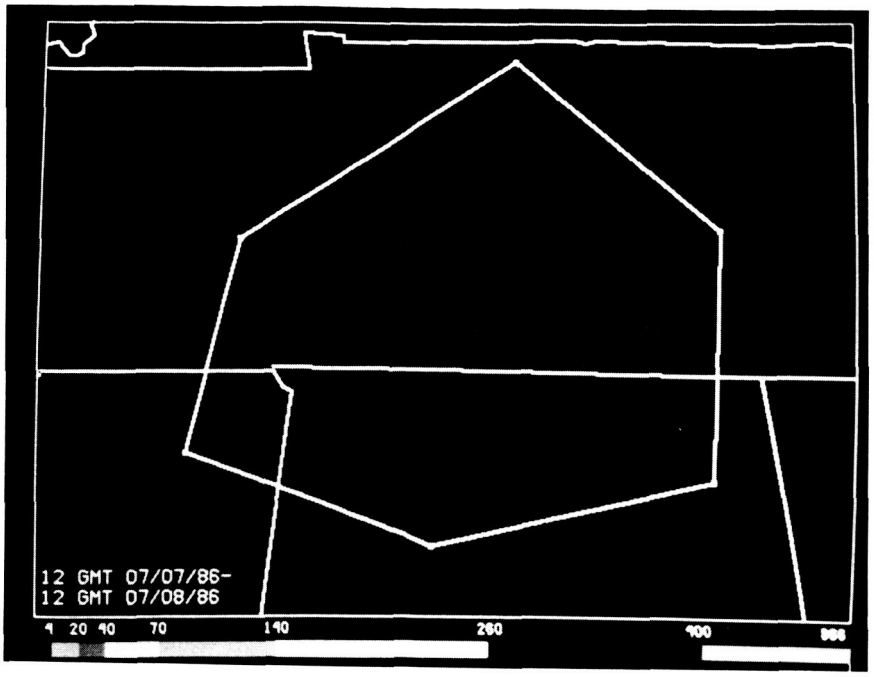


Fig. 3.2-36d. Twenty-four hour lightning strike density plot for 7-8 July 1986

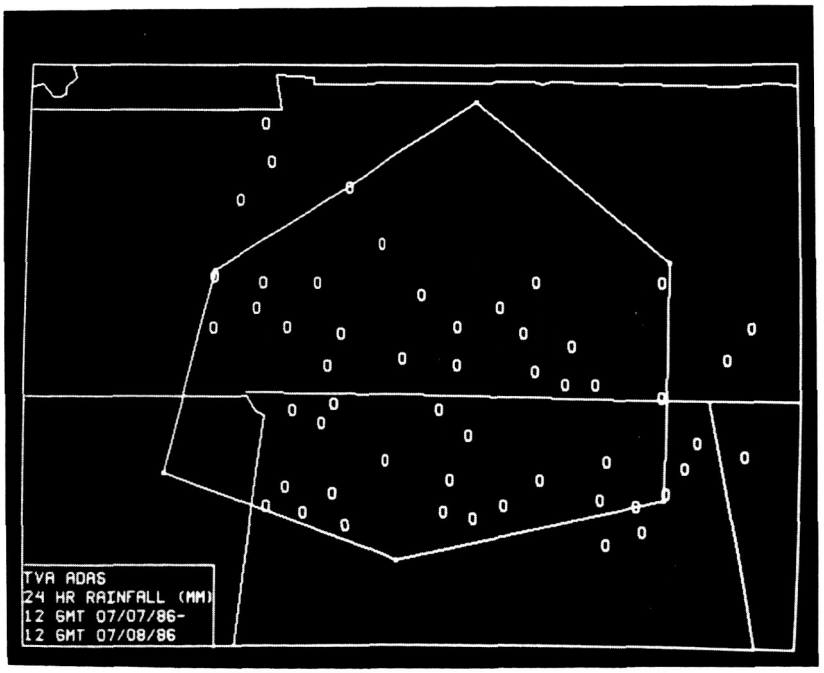


Fig. 3.2-36e. Twenty-four hour TVA ADAS rainfall totals (mm) for 7-8 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

8 July 1986

Synoptic Conditions

The subtropical ridge remained over the Southeast but showed signs of drifting eastward and weakening. As a consequence, low level moisture transport by weak southwesterly flow, combined with weaker synoptic scale subsidence (as indicated in the 12-h NGM forecast), produced greater static instability over the SPACE mesonet. Flow was again very weak over the lower troposphere. Afternoon surface temperature and dewpoint values over the SPACE mesonet were bracketed by 33-35 °C and 20-22 °C, respectively. Surface winds over the mesonet increased to 3-5 m s^{-1} from the west-southwest.

Cloud/Precipitation Overview

Convective clouds formed more quickly today (1530 GMT) and achieved a cumulus congestus state by 1600 GMT. Cumulus congestus persisted from 1600 to 1800 GMT (being most numerous over HSV), but then decreased to isolated and more shallow cumulus congestus thereafter. Such observations indicate that subsidence occurred after 1800 GMT and stabilized the atmosphere. Radar echoes during the afternoon hours were primarily isolated. Echo intensities and tops were generally 50 - 55 dBZ and 8 - 10 km, respectively. Only three echo groups attained appreciable stature: one at 105° at 105 km, a second at 310° at 80 km and a third group at 220° at 80 km (CP-4 polar coordinates). The cell group at 220° at 80 km was most intense and started as the previous ones, but grew much taller (14 km) and more intense (65 dBZ). General storm structure was linear and multicellular. FL-2 personnel noted microburst and gust front shear events associated with this intense convection. This should provide an interesting study of storm initiation and intensification.

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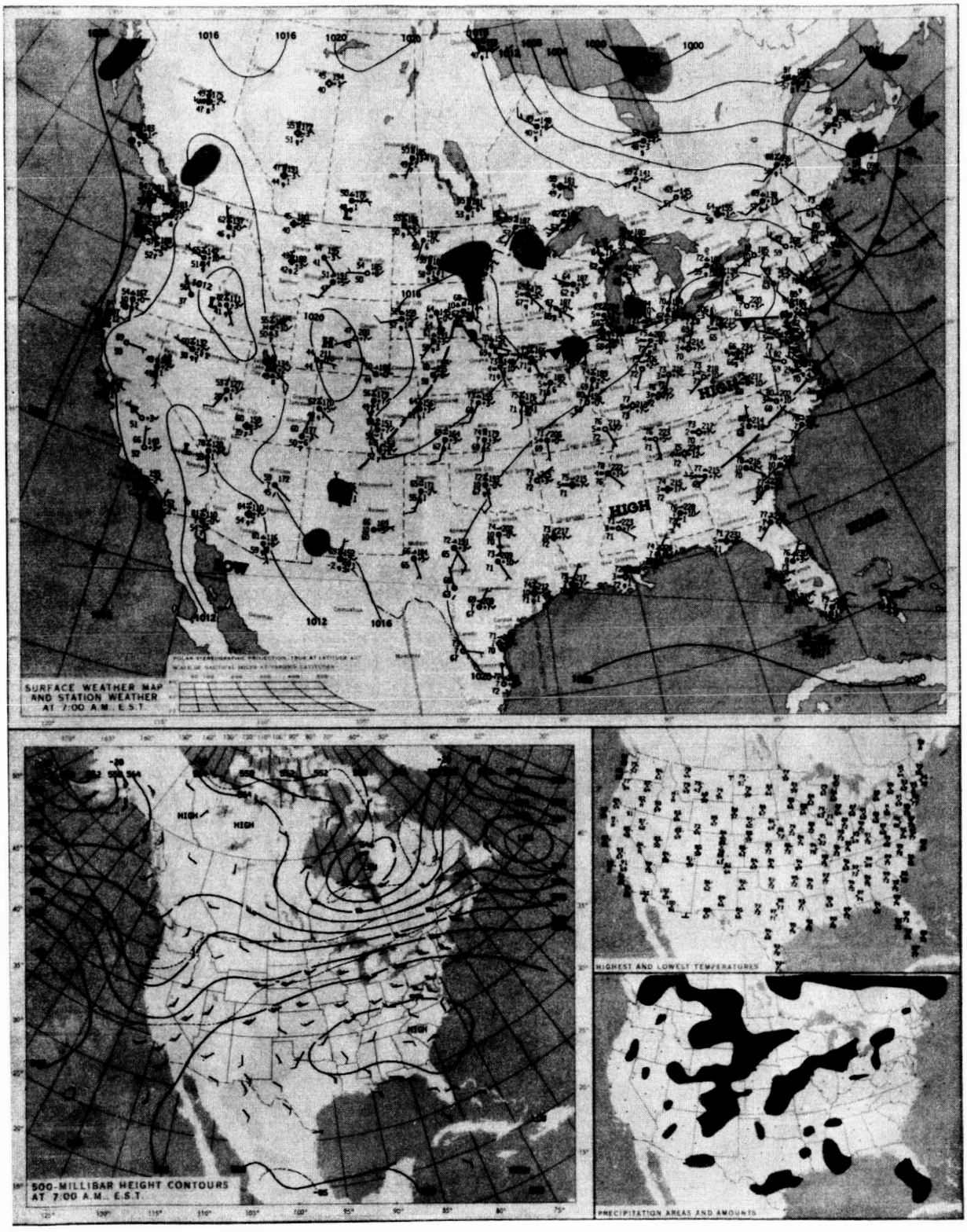


Fig. 3.2-37a. Synoptic weather conditions for 8 July 1986 1200 GMT

OPERATIONAL SUMMARY

8 July 1986

Rawinsonde Operations

The Meso-gamma network provided soundings at 90-min intervals beginning at 1800 GMT and ending 2230 GMT. All soundings appear to be good.

Radar Operations

Surveillance and miscellaneous scans were conducted by CP-2 from 1700 to 1920 GMT. From 1920 to 2300 GMT, CP-2 provided primarily RHI and sectorized PPI scans in support of aircraft flights. CP-4 did surveillance work from 2000 to 2200 GMT, and sectored PPI scans on an intense multicellular storm to the southwest from 2200 to 2300 GMT. CP-3 provided miscellaneous scans from 2000 to 2320 GMT. The evolution of the most interesting storm to the southwest should be well documented with single Doppler radar. Full volume PPI scans and selected RHIs were completed by CP-2, CP-3 and CP-4.

Satellite Operations

Normal GOES satellite operations were conducted. VAS products were generated from 1000 to 2200 GMT.

Aircraft Operations

The ER-2 performed a combined but limited sounding and precipitation mission (MAMS, HIS, AMMS, MTS, MPR, LIT) over the SPACE mesonet from 2000 to 2300 GMT. Sounding profiles were acquired along two east-west legs over the southern SPACE mesonet from 2000 to 2100 GMT. Overflights of three contrasting storms were then executed from 2100 to 2300 GMT, including several passes over the intense storm complex 60 km southwest of the Doppler radars.

The T-28 sampled the most intense storm system located about 60 km southwest of the Doppler radars. Four penetrations were accomplished within this complex from 2215 to 2245 GMT. Unfortunately, the PMS data recorder failed, and other *in situ* data are questionable.

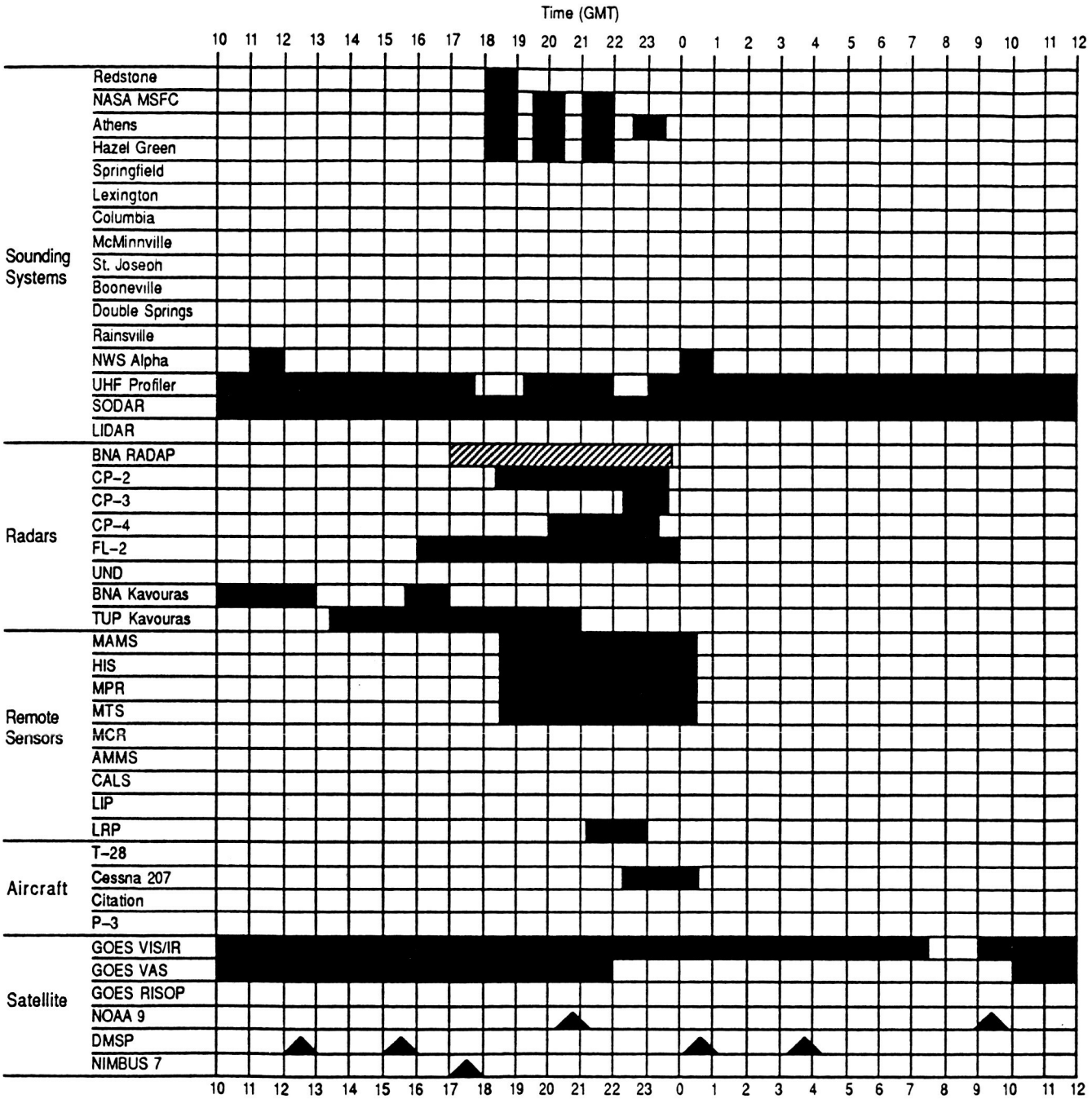
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5-550-7-8(37)

Day: TUESDAY
Date: 7/8/86
Julian Day: 189–190

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 5 & 9
	TVA ADAS	MISSING STATIONS 12, 16, 21, 30, 35, 45, 46 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

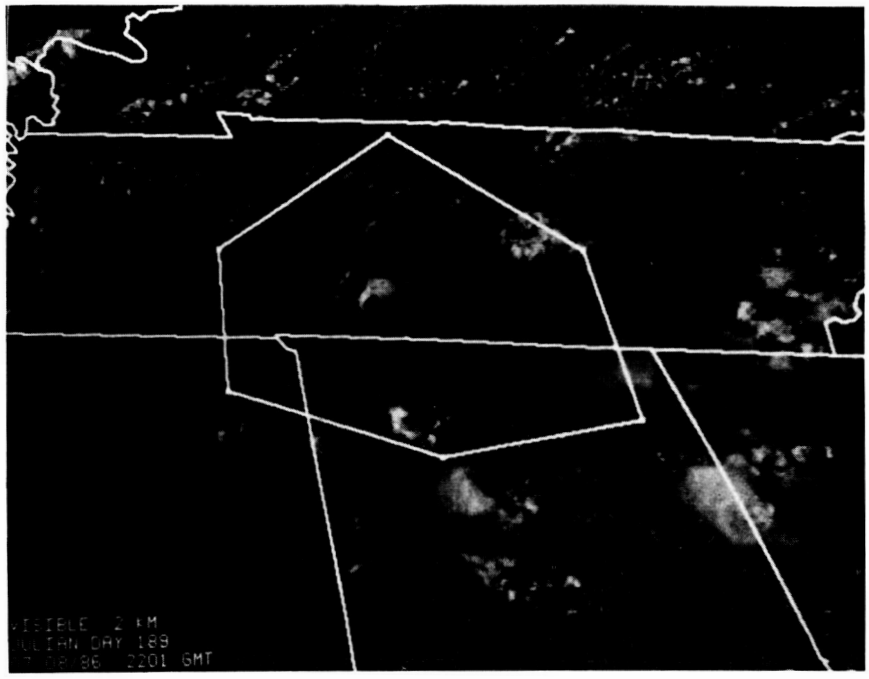


Fig. 3.2-37b. Visible 2 km GOES Central satellite image for 8 July 1986 2201 GMT

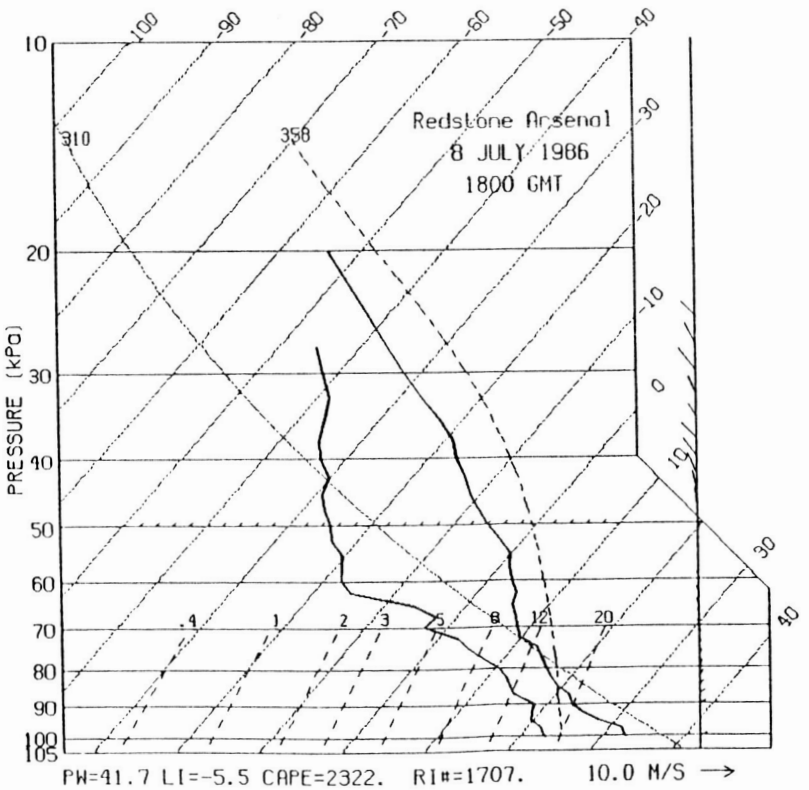


Fig. 3.2-37c. Redstone Arsenal, AL, rawinsonde sounding for 8 July 1986 1800 GMT

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Fig. 3.2-37d. Twenty-four hour lightning strike density plot for 8-9 July 1986

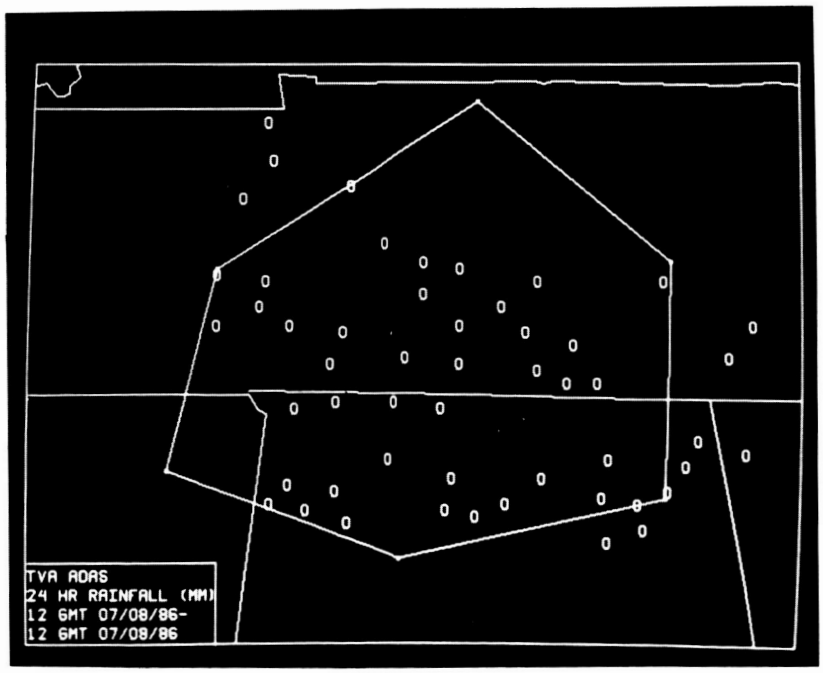


Fig. 3.2-37e. Twenty-four hour TVA ADAS rainfall totals (mm) for 8-9 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

9 July 1986

Synoptic Conditions

The subtropical high continued to advance southeastward and weaken during the day, thereby allowing a return of westerly flow over the SPACE mesonet. Output from the morning NGM run indicated a weak but sustained upward motion over the SPACE region during the day. Lifted indices retrieved from morning VAS products showed an east-west band of unstable air through central Tennessee, precisely where deep convection later developed. Maximum afternoon surface temperatures and dewpoints over the SPACE mesonet were 31-34 °C and 20-23 °C, respectively. Surface winds were again west-southwesterly at ~5 m s^{-1}.

Cloud/Precipitation Overview

Convective clouds again formed relatively early at 1530 GMT. Cumulus congestus clouds appeared locally from 1630 to 1800 GMT, but then diminished after 1800 GMT, similar to yesterday's scenario. A well defined east-west precipitating convective line formed over south-central Tennessee by 1800 GMT within an area previously occupied by an enhanced broad band of cumulus clouds. This line subsequently intensified during the next hour to become nearly 300 km long while only 15-20 km wide. By 1930 GMT a segment of the line had expanded and intensified, eventually producing a small circular MCS, while cells within the remainder of the line weakened. Cells within the intense portion achieved reflectivity factor exceeding 60 dBZ and echo tops peaking at 14 km. Significant rotation was apparent at lower to middle levels within some of the more intense cells. Rainfall amounts over the central portion of the SPACE mesonet were likely locally heavy.

Two other east-west lines appeared to the south during the afternoon hours. One broken line formed 40-50 km southeast of CP-4 but did not persist. A third line formed about 110 km to the south. All activity subsided surprisingly early by 2200 GMT after having been quite intense. It would appear that larger scale subsidence acted to stabilize the regional environment. This stabilizing mechanism appears to have disappeared by 0000 GMT, when a field of altocumulus and cumulus moved into the HSV area from the northwest.

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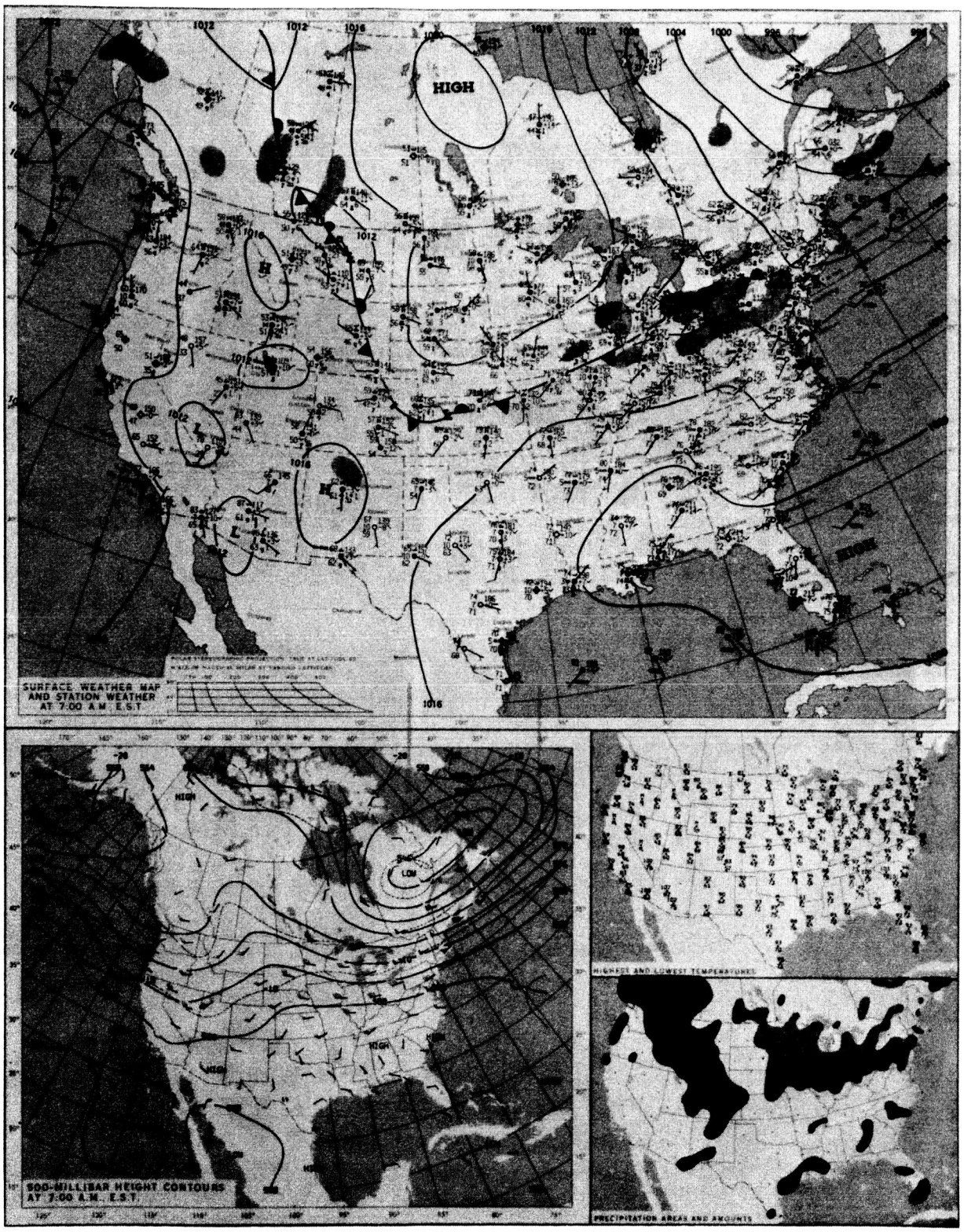


Fig. 3.2-38a. Synoptic weather conditions for 9 July 1986 1200 GMT

OPERATIONAL SUMMARY

9 July 1986

Rawinsonde Operations

A 3 station Meso-gamma rawinsonde operation was conducted from 1930 to 2230 GMT. However, closest deep convection was located ~80 km to the north.

Radar Operations

All three NCAR Doppler radars conducted scans on the three convective lines described above. The MCS located 80 km to the north was thoroughly scanned in PPI and RHI mode by all radars. Its evolution should be very well documented from formation to dissipation. CP-4 executed surveillance and PPI scans, and both CP-2 and CP-3 conducted RHI and PPI scans. FL-2 implemented NEXRAD scanning during the afternoon.

Satellite Operations

VAS products were received until 1530 GMT, after which RISOP was begun. The VAS information accurately documented an isolated band of instability over central Tennessee. Deep convection later developed within this zone.

Aircraft Operations

The T-28 made five penetrations into several cells within a well developed, mature MCS located 80 km north. An initial penetration was made within a dying cell located with stratiform precipitation. Subsequent penetrations were made through newer and more active cells which developed along the northeastern edge of the larger scale system. On station time was approximately 2030 to 2130 GMT.

Notes:

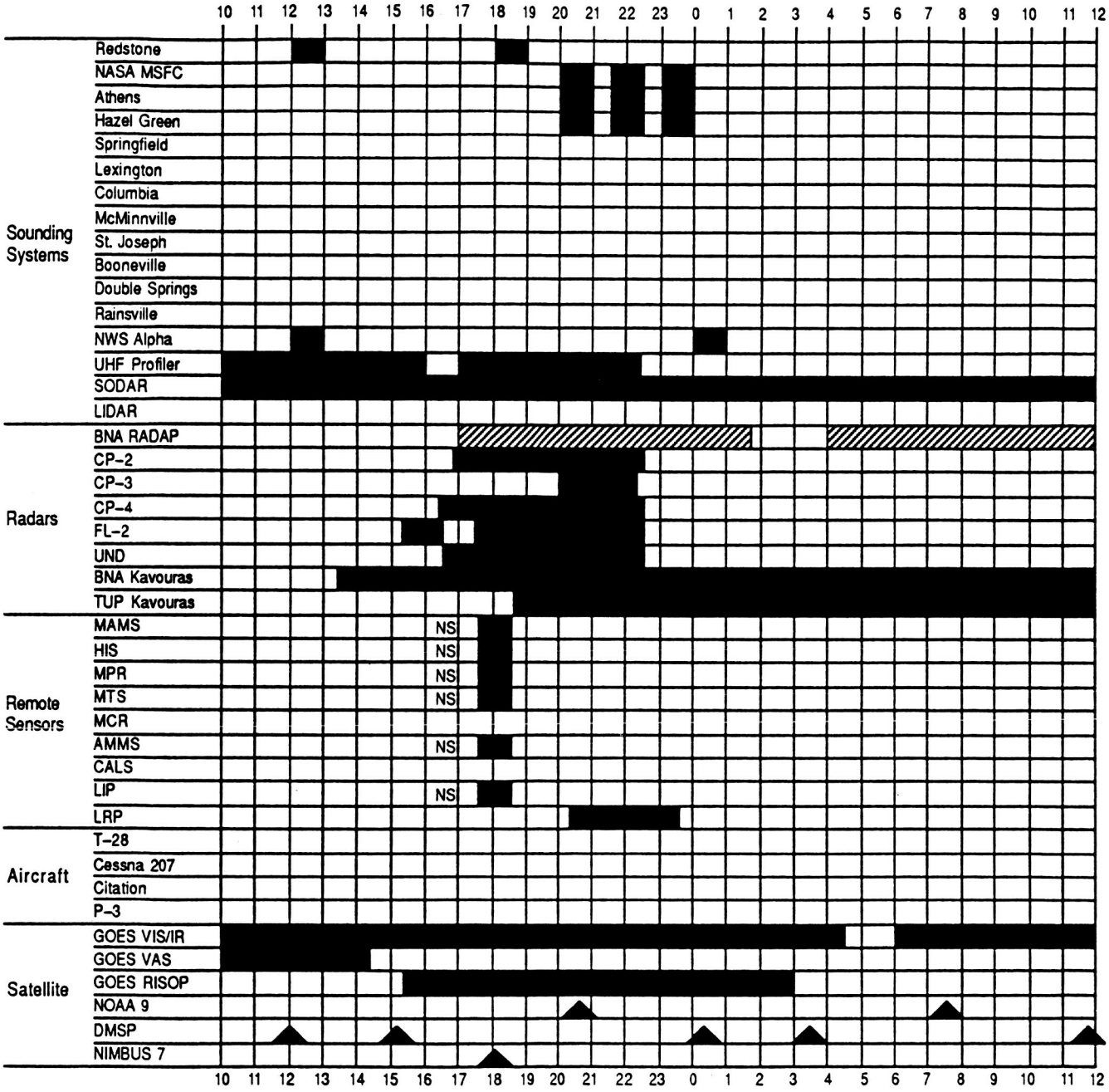
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5-550-7-8(38)

Day: WEDNESDAY
Date: 7/9/86
Julian Day: 190–191

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 5, 6 & 9
	TVA ADAS	MISSING STATIONS 12, 16, 21, 35 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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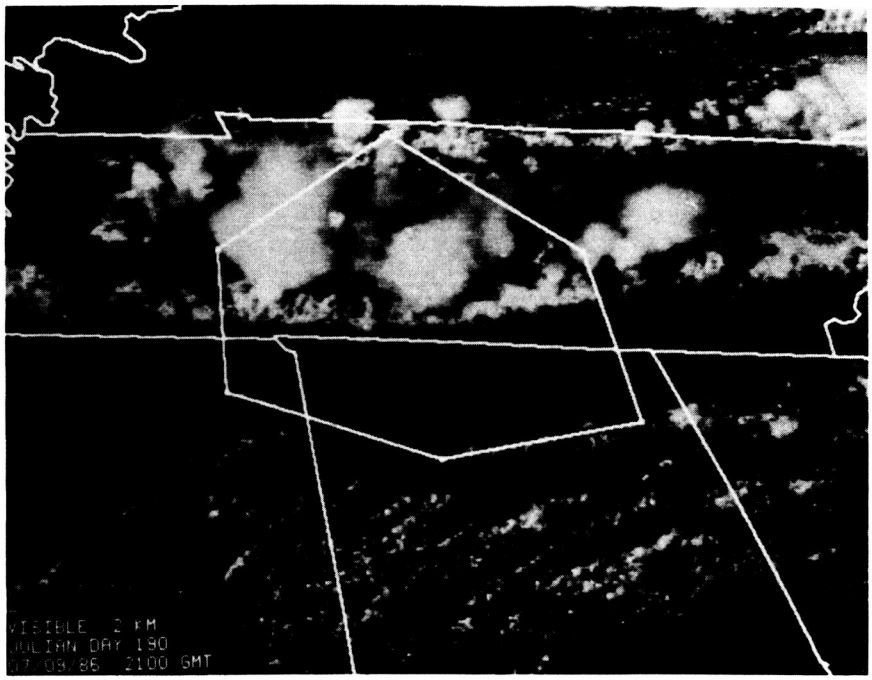


Fig. 3.2-38b. Visible 2 km GOES Central satellite image for 9 July 1986 2100 GMT

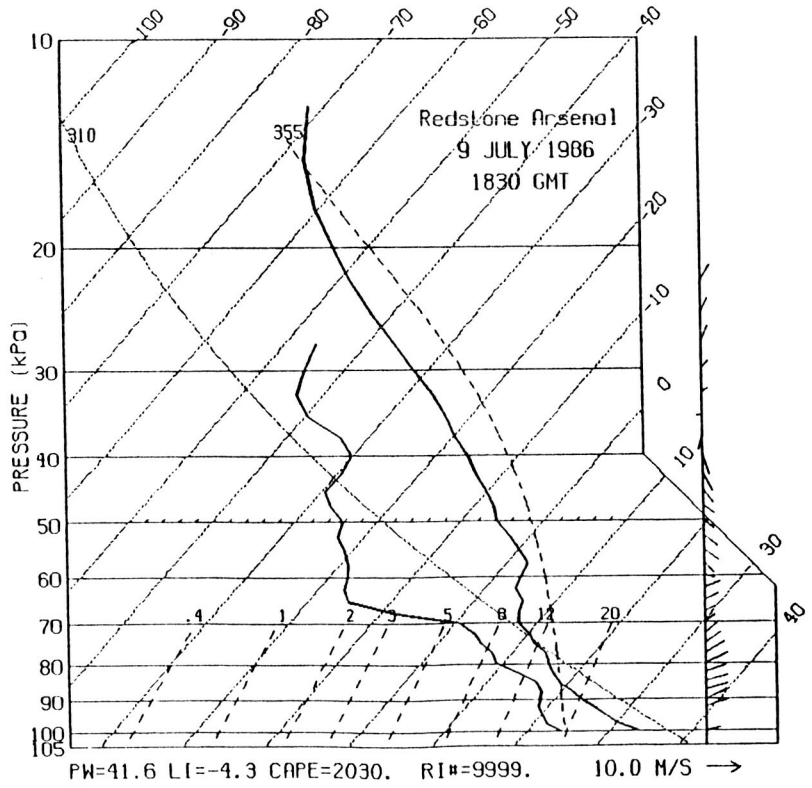


Fig. 3.2-38c. Redstone Arsenal, AL, rawinsonde sounding for 9 July 1986 1830 GMT

C-4

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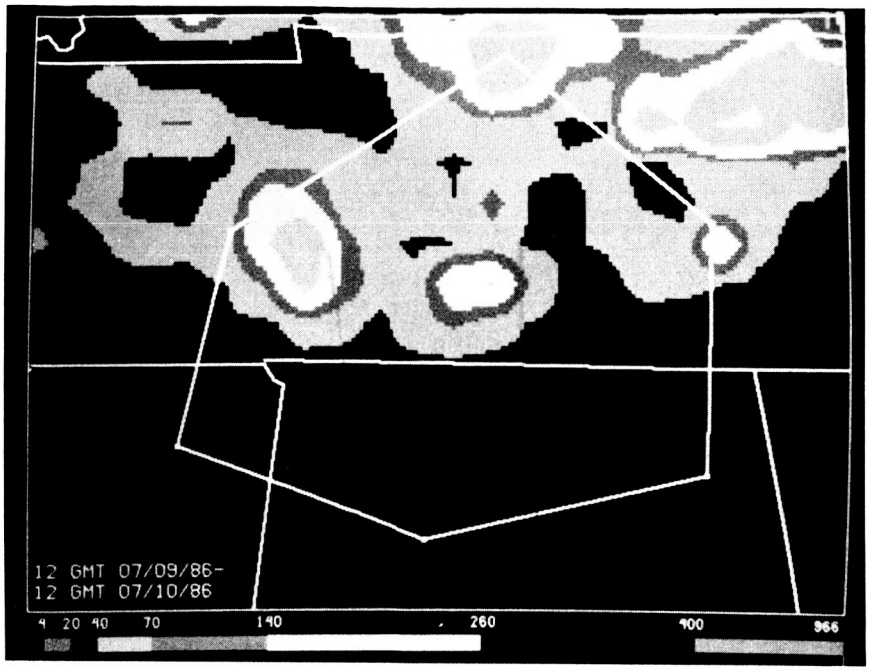


Fig. 3.2-38d. Twenty-four hour lightning strike density plot for 9-10 July 1986

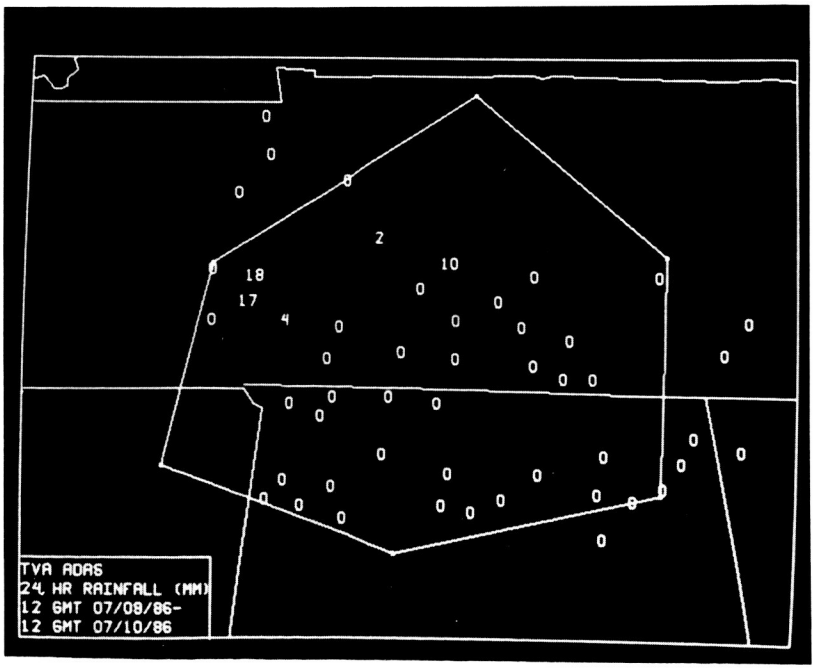


Fig. 3.2-38e. Twenty-four hour TVA ADAS rainfall totals (mm) for 9-10 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

10 July 1986

Synoptic Conditions

Westerly flow continued to strengthen at lower to middle levels over the SPACE as the subtropical ridge weakened. Strongest wind speeds of ~10 m s^{-1} existed near 700 mb. Abundant moisture continued to be present at levels below 700 mb. Over the SPACE mesonet, the air mass showed moderate instability, with lifted indices in the -3 to -4 range. At the surface, afternoon temperature and dewpoint values were fairly uniform over the SPACE mesonet at 32-33 °C and 20-22 °C, respectively. Surface flow was southwesterly at 3-6 m s^{-1}.

Cloud/Precipitation Overview

First echoes formed by 1300 GMT west of the Appalachians in east-central Tennessee. Convective activity over the beta network was generally weak and isolated throughout the afternoon hours. An area of moderate to intense thunderstorms was located north of the mesonet along a stationary front over southern Kentucky and extreme northern Tennessee from 1800 to 0000 GMT. Some of the cells in the region extended southward into the northeastern portion of the beta network.

Late cumulonimbus development over the northwest corner of the MIST/FLOWS network, and over the southern border of the SPACE mesonet was observed around 2300 GMT. The cumulonimbus cluster near the MIST/FLOWS network consisted of several moderately intense cells showing reflectivity to 50+ dBZ and echo tops to 12 km. These produced cloud to ground lightning and at least two moderately intense microbursts displaying low level velocity differentials up to 21 m s^{-1}. Subsequent outflow from initial activity then generated secondary cells nearby.

Notes:

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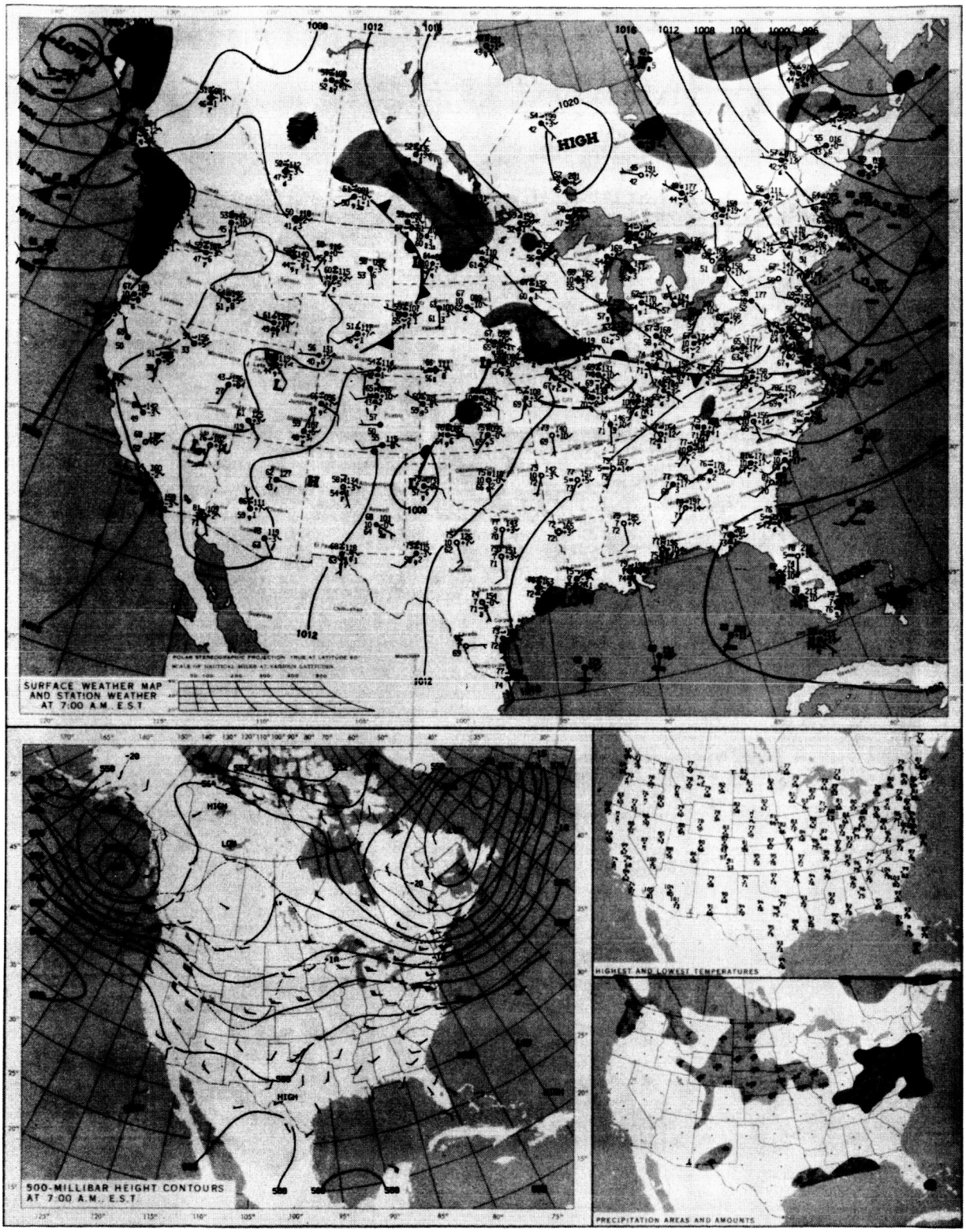


Fig. 3.2-39a. Synoptic weather conditions for 10 July 1986 1200 GMT

OPERATIONAL SUMMARY

10 July 1986

Rawinsonde Operations

A 9 station Meso-beta rawinsonde operation was run from 1500 to 0000 GMT. The most useful soundings will be those near the MIST/FLOWS network at 2300 GMT, and those along the northern border during the afternoon hours.

Radar Operations

Radars conducted primarily surveillance scans throughout the afternoon hours. CP-2 acquired detailed data on the life cycle on at least one small cloud showing warm rain processes around 1800 GMT. CP-4 similarly conducted RHI scans for 15-min on a cell exhibiting an echo top to 6-7 km. Only a few cells were noted within the 115 km range circle of CP-4 throughout the afternoon. No dual Doppler data were acquired. FL-2 was the only Doppler to catch the tail end of the late developing cumulonimbus over the northwest MIST/FLOWS network.

Satellite Operations

GOES RISOP was started at 1930 GMT. Computer problems at UW prevented the archival of VAS to 1930 GMT.

Aircraft Operations

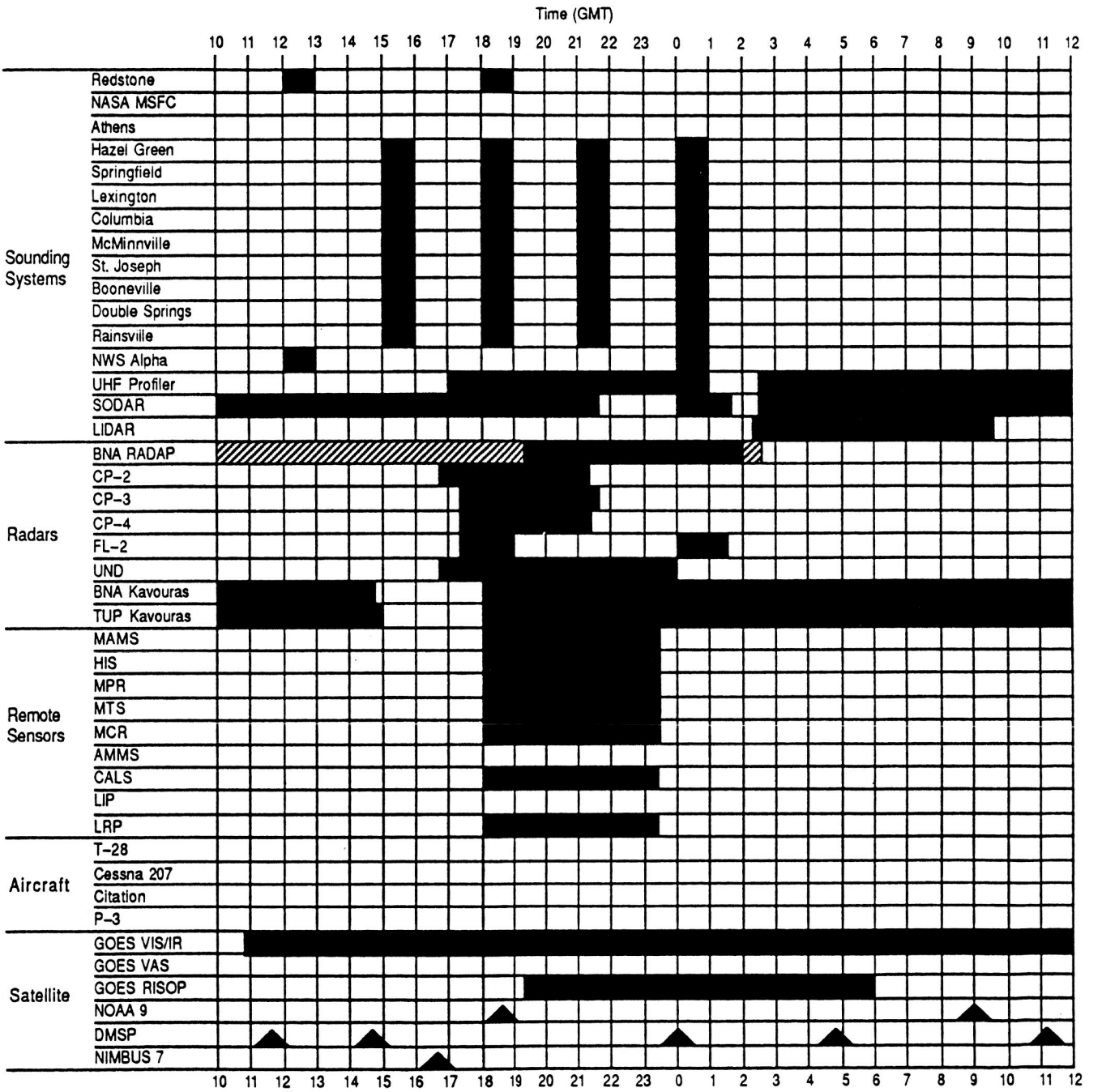
The ER-2 conducted a combined sounding and cloud mission over the SPACE mesonet from 1830 to 2100 GMT. An initial north-south sounding leg was flown over the east-central portion of the network. Cumulonimbus clouds near the Tennessee-Kentucky border were then examined.

Notes:

5-550-7-8(39)

Day: THURSDAY
Date: 7/10/86
Julian Day: 191–192

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 5 & 6
	TVA ADAS	MISSING STATIONS 12, 16, 21 & 57
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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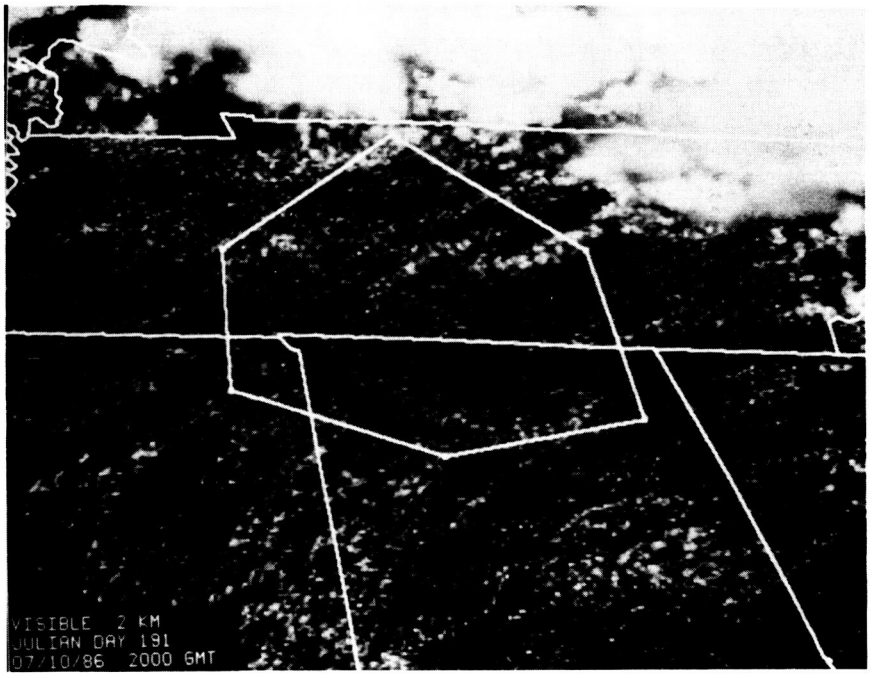


Fig. 3.2-39b. Visible 2 km GOES Central satellite image for 10 July 1986 2000 GMT

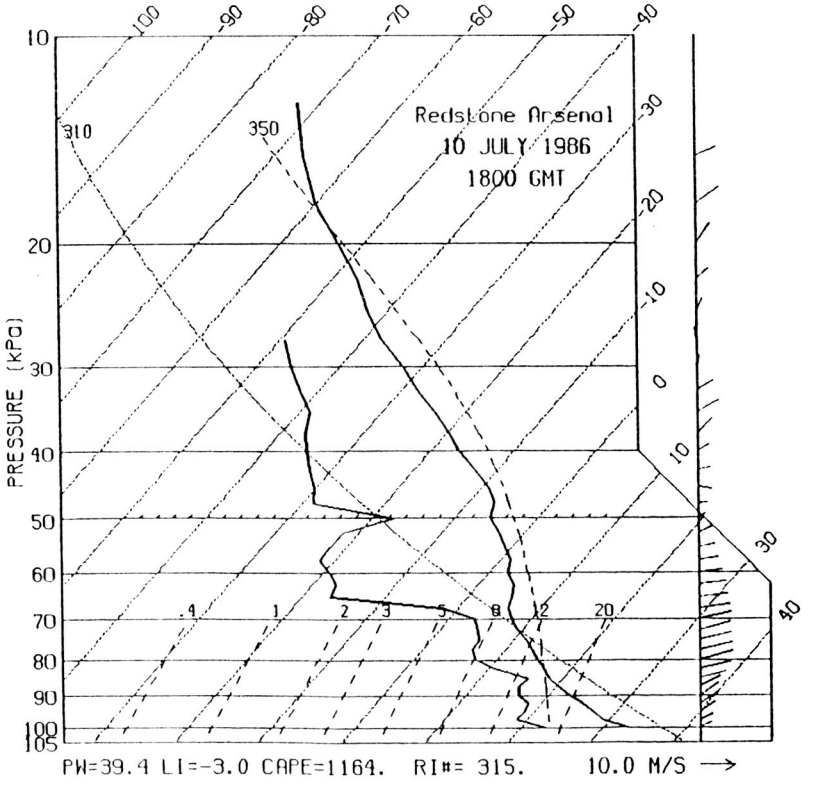


Fig. 3.2-39c. Redstone Arsenal, AL, rawinsonde sounding for 10 July 1986 1800 GMT

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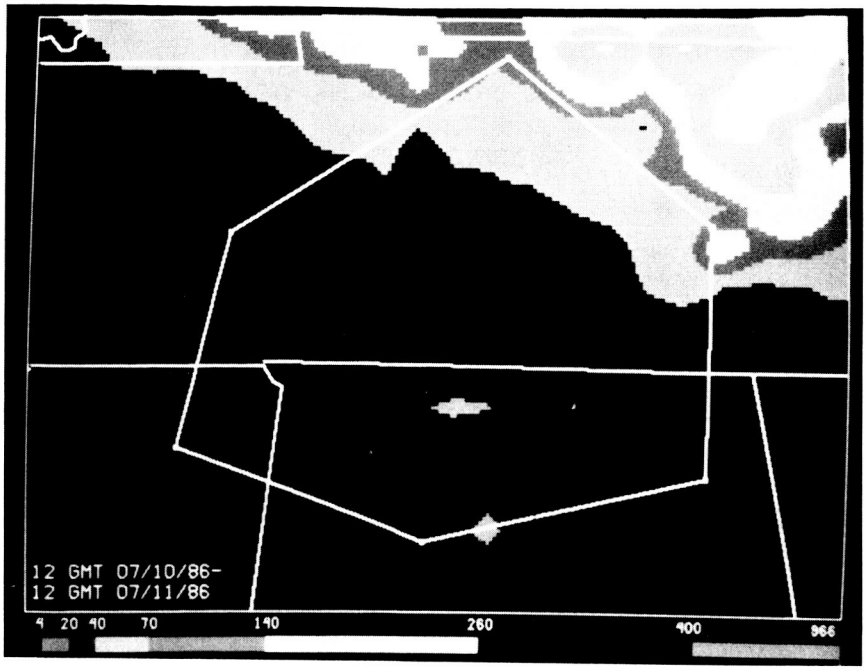


Fig. 3.2-39d. Twenty-four hour lightning strike density plot for 10-11 July 1986

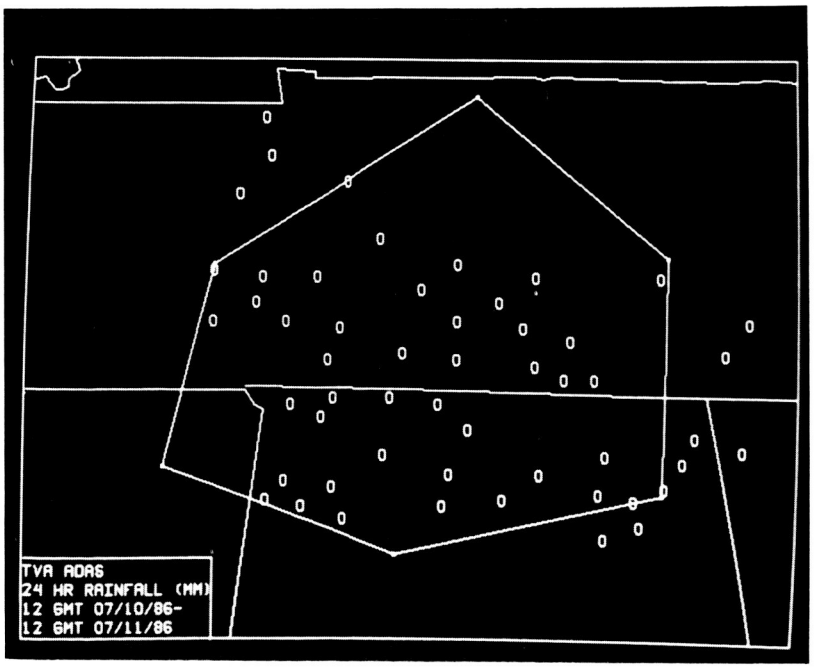


Fig. 3.2-39e. Twenty-four hour TVA ADAS rainfall totals (mm) for 10-11 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

11 July 1986

Synoptic Conditions

Westerly flow and associated wind shear increased from yesterday over the SPACE mesonet as the ridge dropped further south in advance of an approaching short wave trough. A maximum wind speed of nearly 15 m s^{-1} at 750 mb appears on the 1800 GMT RSA sounding. Total precipitable water also showed small increases over yesterday's values as moisture amounts increased in the 700-500 mb layer. Meanwhile a slowly moving short wave trough advanced eastward over Oklahoma during the day. At the surface, temperature and dewpoint values over the SPACE mesonet were uniform at 30-32 °C and 19-22 °C, respectively. Surface winds from the west-southwest were relatively brisk at 4-7 m s^{-1}.

Cloud/Precipitation Overview

Scattered cloudiness existed over the beta network from morning to afternoon hours. By 1530 GMT, cumulus mediocris and stratocumulus clouds had formed in the HSV region, and cumulus congestus were observed by 1630 GMT. First echoes formed over the northeastern portion of the Meso-beta network by 1600 GMT. The number of scattered echoes appeared to maximize around 1800-1900 GMT over the Meso-beta network. During the afternoon hours, several cloud systems affected the central SPACE and MIST/FLOWS networks. An initial cloud system (~1730 GMT) displayed little radial velocity structure but attained maximum reflectivity factor of 55 dBZ. A second intensifying cloud line (1930-2130 GMT) oriented north-south moved over the MIST/FLOWS network. This line, well sampled by aircraft and Doppler radar, produced at least one microburst and locally heavy rainfall over the MIST/FLOWS network. During the period of observation, individual cells increased in intensity from ~50 dBZ to ~65 dBZ, and showed increases in echo top from 11 km to 14 km.

A third cluster consisting of two strong thunderstorms formed west of the MIST/FLOWS network around 2030 GMT, but weakened quickly after 2200 GMT. These cloud systems exhibited both visual and radar echo characteristics typical of supercell thunderstorms. Finally, a strong MCS developed and moved over the southeastern portion of the beta network by 2230 GMT. Individual thunderstorm cells within this MCS exhibited significant rotation, strong reflectivity and tops to 16 km. The stratiform region of this system showed well defined inflow and outflow patterns throughout the storm depth in Doppler radial velocity patterns.

This was in general a very active day in which a wide variety of convective storm types was observed. Precipitation amounts were locally heavy but scattered.

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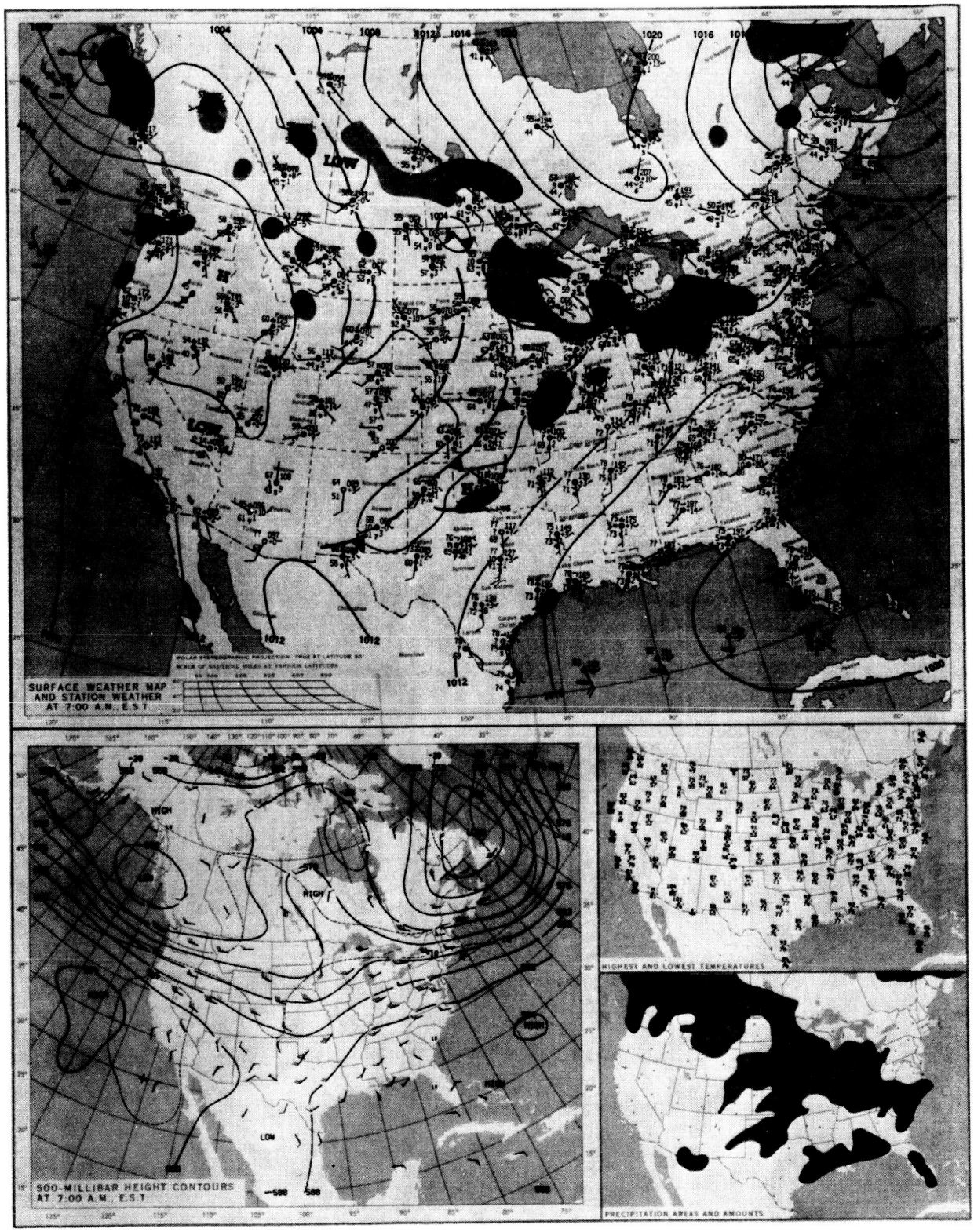


Fig. 3.2-40a. Synoptic weather conditions for 11 July 1986 1200 GMT

OPERATIONAL SUMMARY

11 July 1986

Rawinsonde Operations

A complete Meso-beta rawinsonde operation was conducted at 1930, 2230 and 0130 GMT. These soundings should provide a good measure of the Meso-beta environment which supported a wide variety of different storm structures.

Radar Operations

This was one of the more active Doppler radar days during the COHMEX program. Multiple Doppler radar data were acquired on several storms: (a) a kinematically inactive storm which skirted the northern portion of the MIST/FLOWS network from 1700 to 1830 GMT; (b) a convective line which passed over the MIST/FLOWS network from 1930 to 2130 GMT, intensifying over the MIST/FLOWS network; (c) the weakening stages of a pair of storms located just west of the MIST/FLOWS network from 2130 to 2200 GMT; and (d) weak convection over the southwest portion of the MIST/FLOWS network from 1920 to 1930 GMT. Finally, single Doppler radar data were acquired on an MCS which passed 80 km southeast of the MIST/FLOWS network from 2230 to 0200 GMT.

Satellite Operations

Potentially valuable VAS products were archived from 1500 to 2200 GMT. These may provide a definition of the variable mesoscale environment that appeared to exist over the SPACE mesonet.

Aircraft Operations

The ER-2 (MAMS, HIS, MPR, MTS, AMMS AND LIP) mission began as a sounding flight, with an initial north-south leg from 2010 to 2030 GMT. From 2030 to 2315 GMT, five convective storms, some intense, were examined over the southern portion of the network, from the MIST/FLOWS network on south. Some of these measurements were acquired with nearly simultaneous observations from the U-2 and from multiple Doppler radar. The U-2 (LRP) sampled the same region during the time interval from 2040 to 2300 GMT.

The T-28 acquired some limited measurements (a total of 3 penetrations) of dissipating thunderstorms from 2150 to 2210 GMT. The Citation conducted two missions. The first consisted of flying box patterns near the 5 km level around a kinematically weak cell being examined by multiple Doppler radar. For the remainder of the first mission, the low level outflow of a weak convective cell was measured. During the second mission, low level outflow associated with a north-south line of convective cells, located over the MIST/FLOWS network, was examined. This line dissipated near 2130 GMT. The Citation then flew to intense thunderstorm activity located west of the MIST/FLOWS network.

Mobile Laboratory Operations

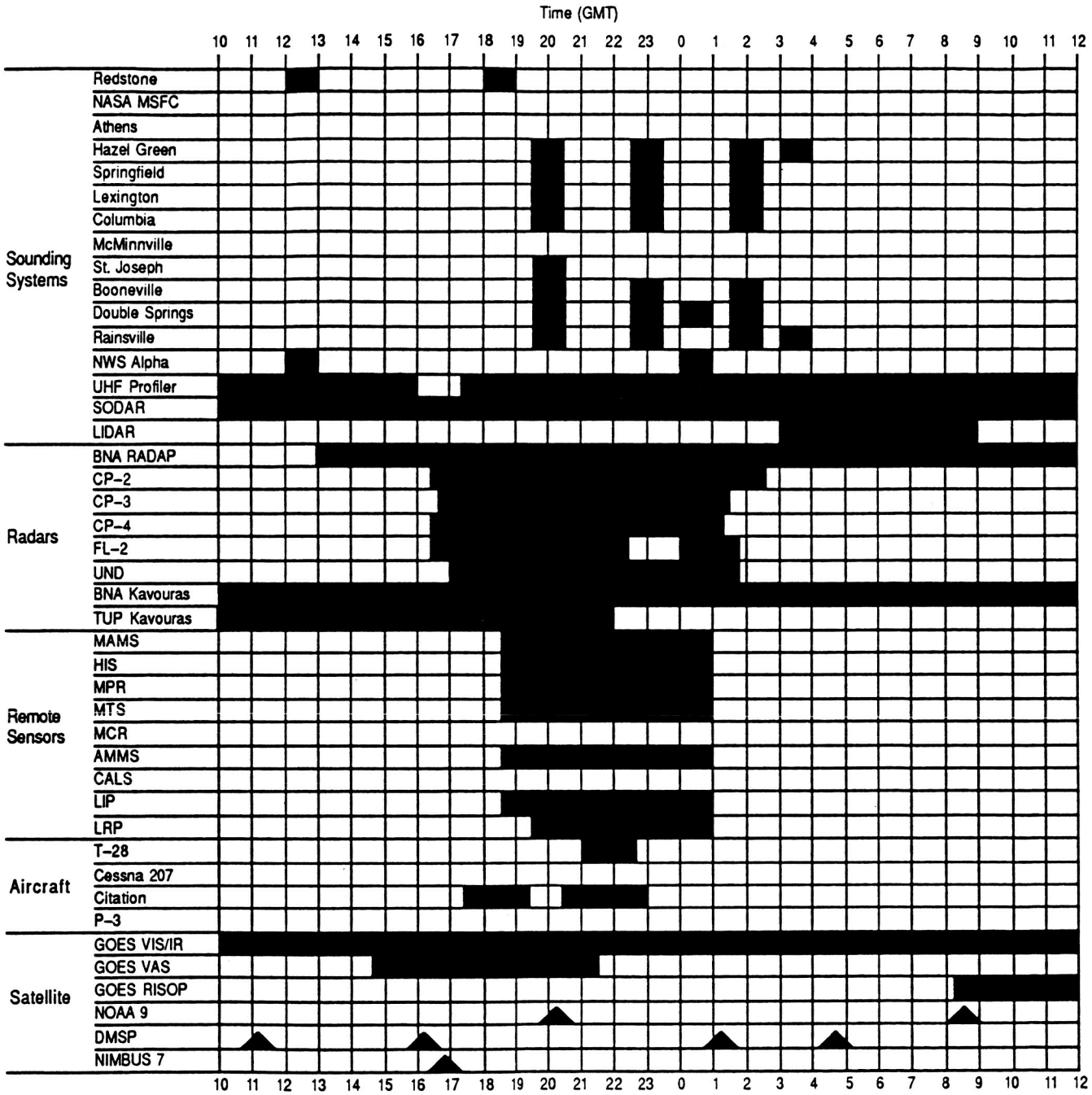
The mobile electrical laboratory released special balloons at 1820 GMT (70° at 50 km from CP-2), at 2130 GMT into a convective line (128° at 18 km from CP-2) and at 0022 GMT into the northern portion of an MCS located at 173° and 70 km from CP-2.

5-550-7-8(40)

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Day: FRIDAY
Date: 7/11/86
Julian Day: 192-193

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL, DOWN DURING MORNING HOURS
	NAM	MISSING STATIONS 5 & 6
	TVA ADAS	MISSING STATIONS 12, 16, 21 & 45
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

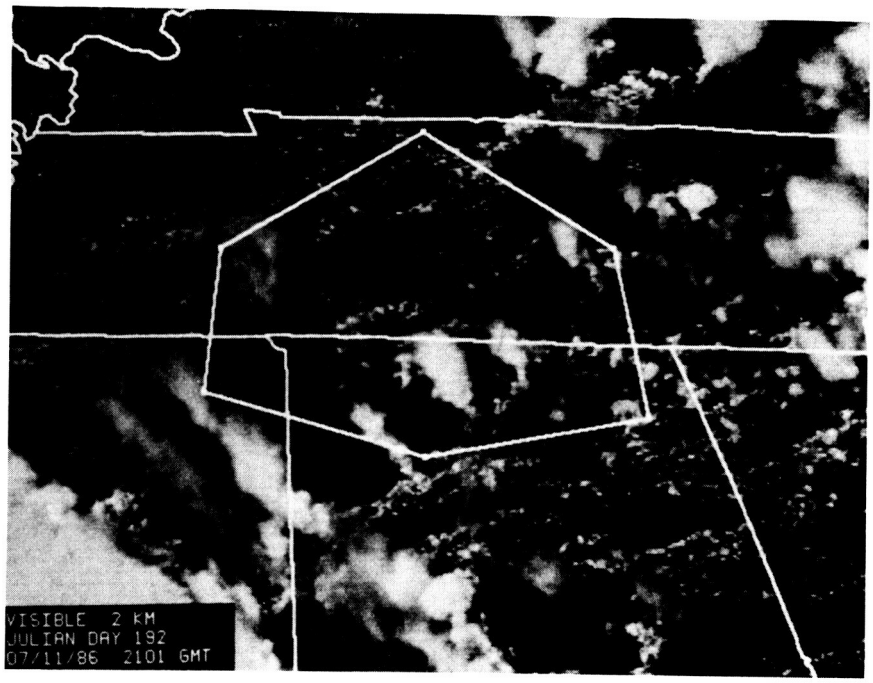


Fig. 3.2-40b. Visible 2 km GOES Central satellite image for 11 July 1986 2101 GMT

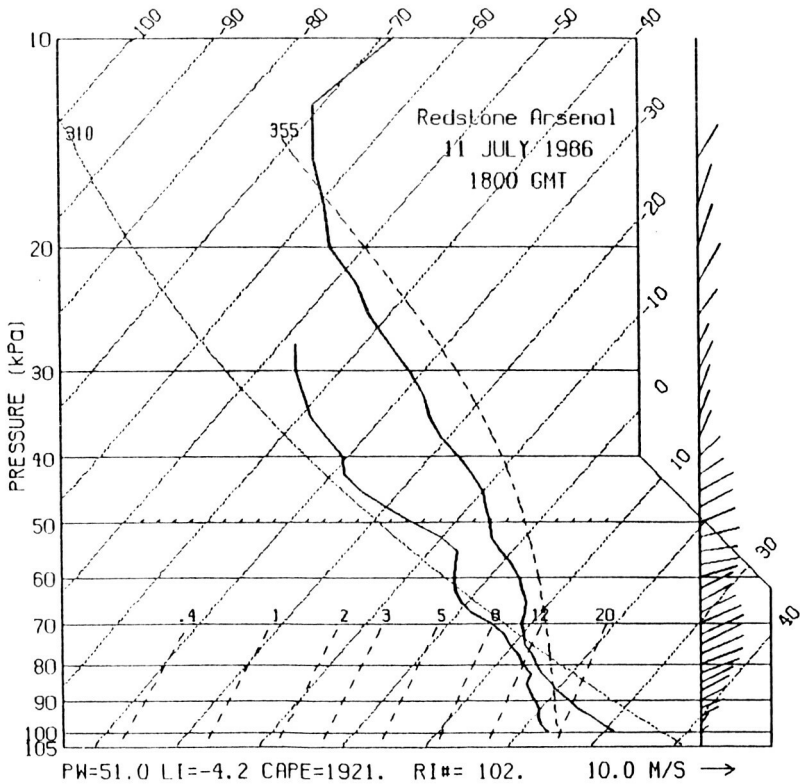


Fig. 3.2-40c. Redstone Arsenal, AL, rawinsonde sounding for 11 July 1986 1800 GMT

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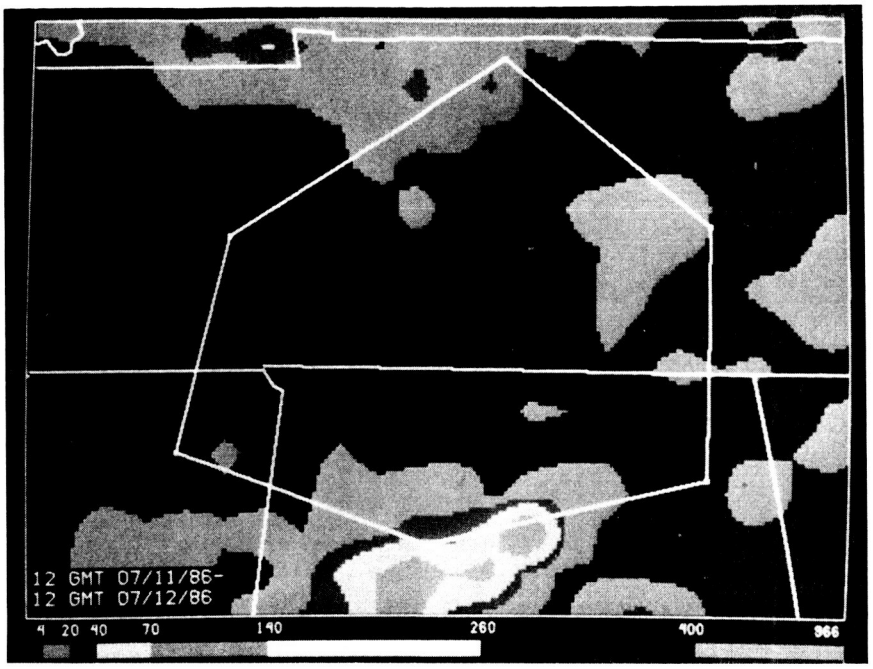


Fig. 3.2-40d. Twenty-four hour lightning strike density plot for 11-12 July 1986

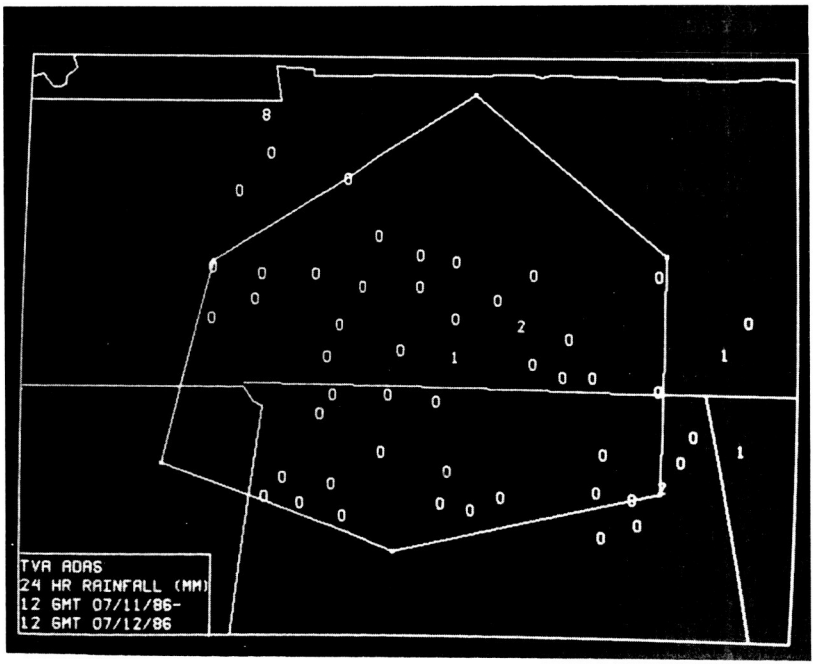


Fig. 3.2-40e. Twenty-four hour TVA ADAS rainfall totals (mm) for 11-12 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

12 July 1986

Synoptic Conditions

The environment over the SPACE mesonet was strikingly similar to that observed yesterday. The 1800 GMT RSA sounding indicates a similar structure in both winds and temperature and dewpoint profiles. A short wave trough located over Oklahoma at 1200 GMT was forecast to move into the region tomorrow. Afternoon surface temperature and dewpoint over the SPACE mesonet were 30-33 °C and 19-21 °C in the presence of 4-6 m s^{-1} west-southwesterly surface flow.

Cloud/Precipitation Overview

During the afternoon hours, convective clouds peaked in coverage around 1900 GMT. The afternoon precipitating convective clouds were most common over northern Alabama to central Tennessee. Individual echoes attained 55 dBZ peak intensities despite exhibiting low echo tops (~8 km) and narrow diameters. These clouds also exhibited very little radial velocity structure. Clusters of cells tended to be arranged in rolls oriented along the low level wind direction (from 240° to 60°). Local cloud activity subsided by midafternoon. However, a linear cloud system moved rapidly (~50 km h^{-1}) over the central beta network during early evening hours (0000 to 0330 GMT). This system originated in southern Missouri as a strong MCS but weakened to a narrow convective line (up to 200 km long) as it moved over the Meso-beta network. One unique aspect of this system was a deep (2-3 km) and relatively strong (~17 m s^{-1}) low level outflow along its leading edge. Some redevelopment of intense convection occurred over the northwest SPACE mesonet around 0300 GMT after the linear gust front system moved through. In general, precipitation amounts over the Meso-beta network were light and scattered.

Notes:

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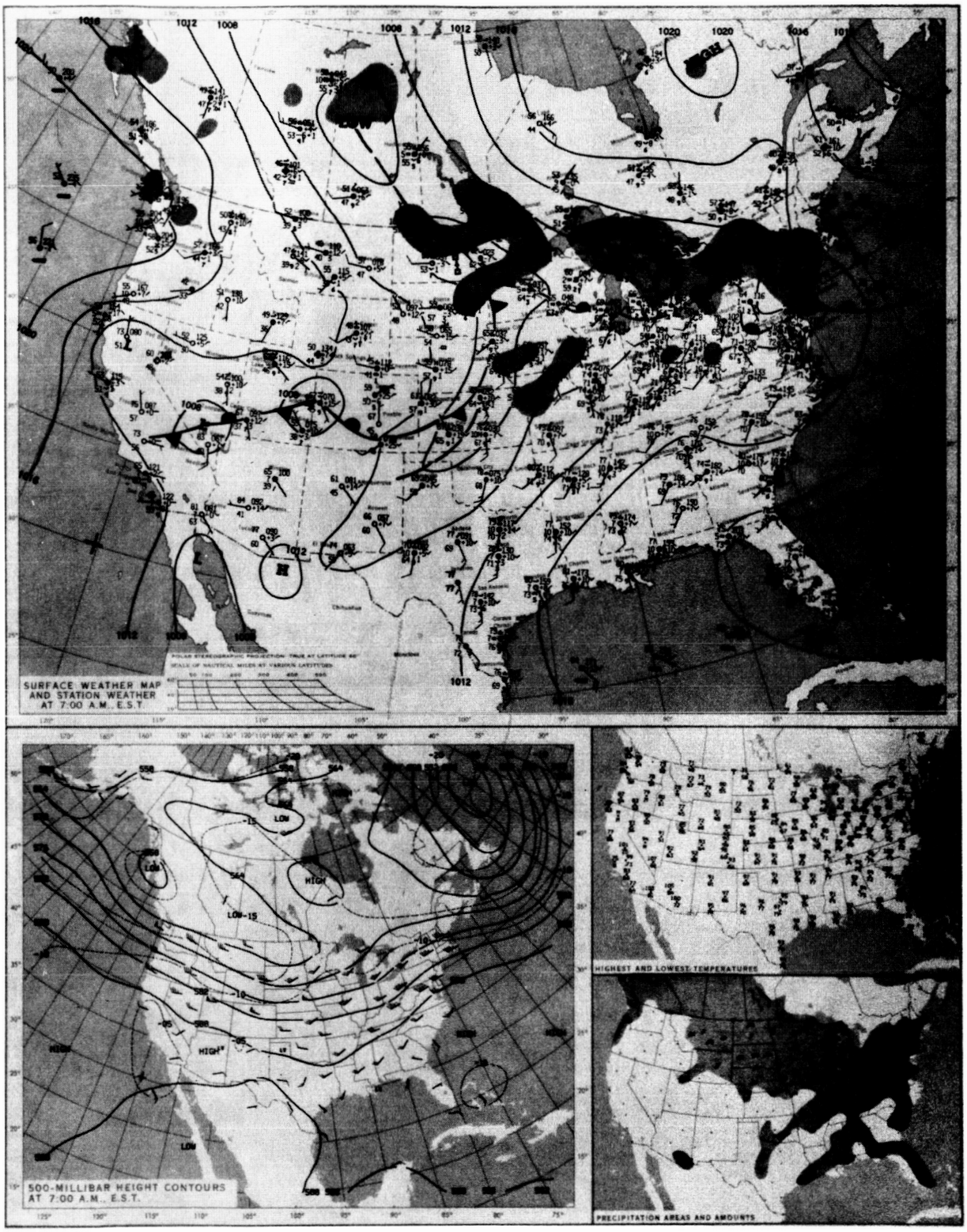


Fig. 3.2-41a. Synoptic weather conditions for 12 July 1986 1200 GMT

OPERATIONAL SUMMARY

12 July 1986

Rawinsonde Operations

A 7 station Meso-beta rawinsonde operation was conducted from 1800 to 0300 GMT at 3-h intervals. The McMinnville and St. Joseph stations were not operational, and the 0300 GMT release included only three stations. This last release was accomplished while the weakening outflow system was over the beta network.

Radar Operations

The Doppler radars conducted scans during the early afternoon and evening hours. During the early afternoon, individual clouds were examined by CP-2. CP-4 conducted primarily surveillance scans. The Doppler radars resumed recording as the southern end of a narrow convective line moved over the beta network from ~0000 to 0330 GMT. The outflow interface of this system was closely examined with both PPI and RHI scans. FL-2 RHI scans indicated a 2-km deep outflow layer which contained radial velocity magnitudes up to 17 m s^{-1}.

Satellite Operations

RISOP was in effect all day. Therefore, no VAS products are available.

Aircraft Operations

The ER-2 (MAMS, HIS, MPR, MTS, AMMS, LIP) flew a combined sounding and cloud flight over the SPACE mesonet from 1830 to 2040 GMT. The sounding portion began at 1830 GMT, with 1.5 north-south flight legs over the central beta network. At 1910 GMT, the sounding pattern was terminated, and weak convective clouds over northern Alabama and south central Tennessee were sampled until about 2030 GMT. This flight should have good CP-2 radar support.

The U-2 conducted a lightning flight over Kentucky, southern Indiana and Ohio from 2130 to 0030 GMT.

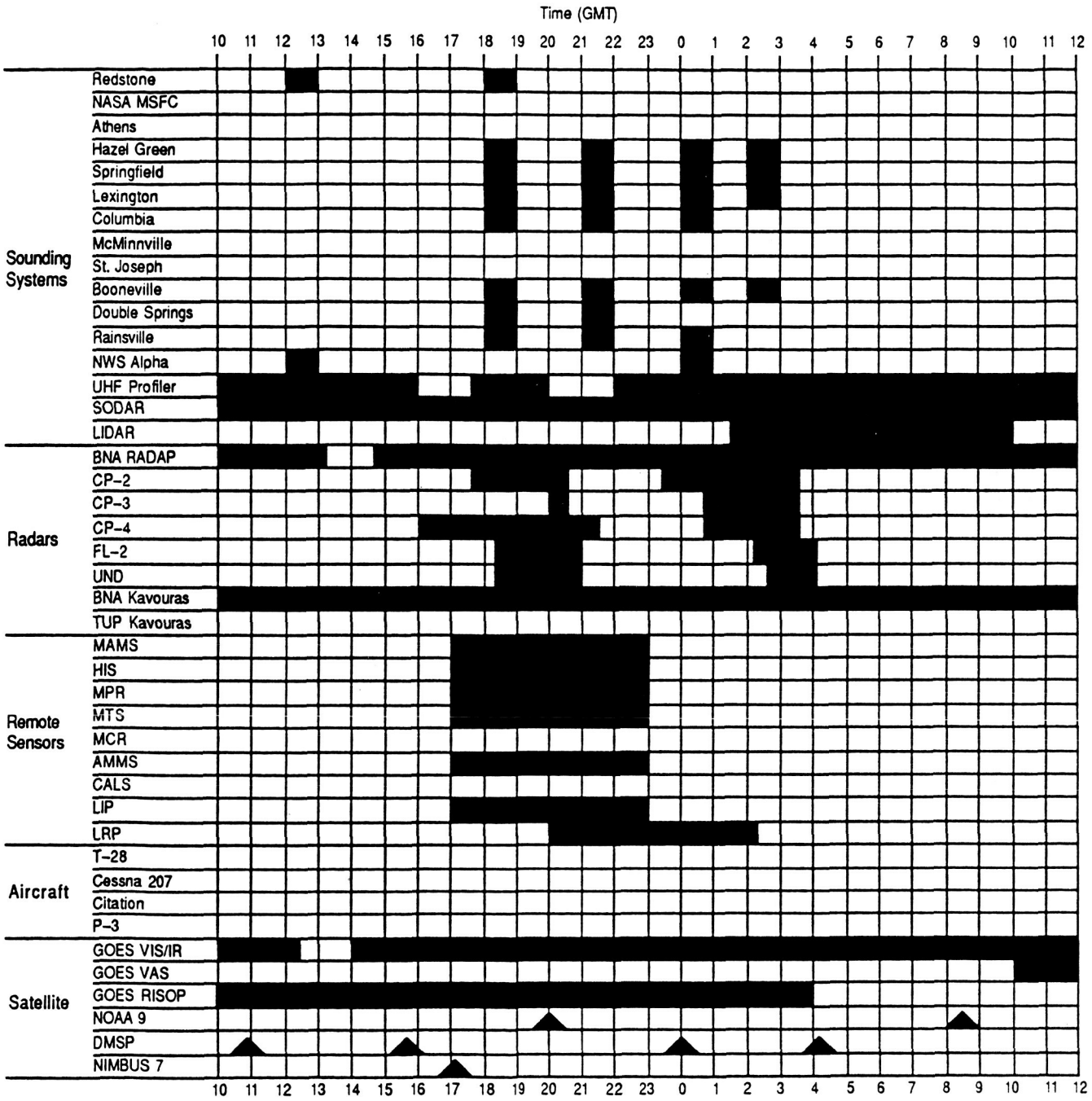
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5-550-7-8(41)

Day: SATURDAY
Date: 7/12/86
Julian Day: 193–194

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	OPERATIONAL
	TVA ADAS	MISSING STATIONS 12, 13, 16, 45 & 56
	LLP	OPERATIONAL
	Mobile Lab	1800–0130 GMT, BALLOON LAUNCH

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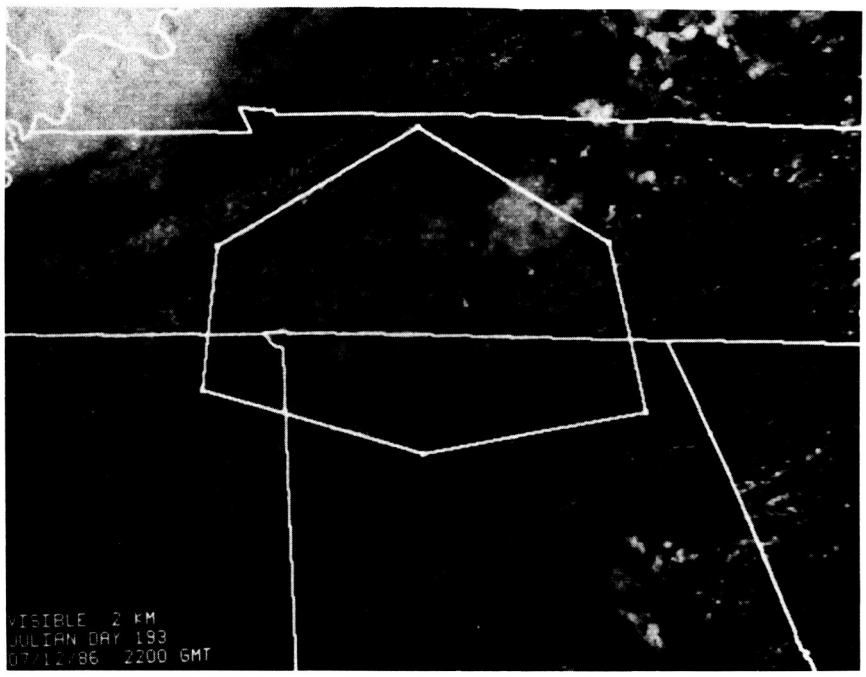


Fig. 3.2-41b. Visible 2 km GOES Central satellite image for 12 July 1986 2200 GMT

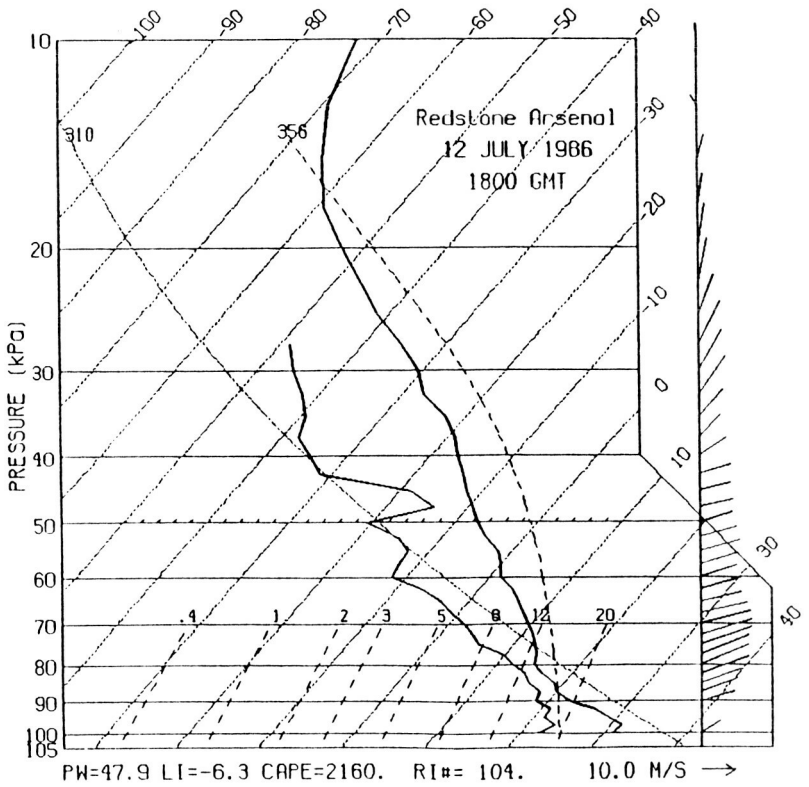


Fig. 3.2-41c. Redstone Arsenal, AL, rawinsonde sounding for 12 July 1986 1800 GMT

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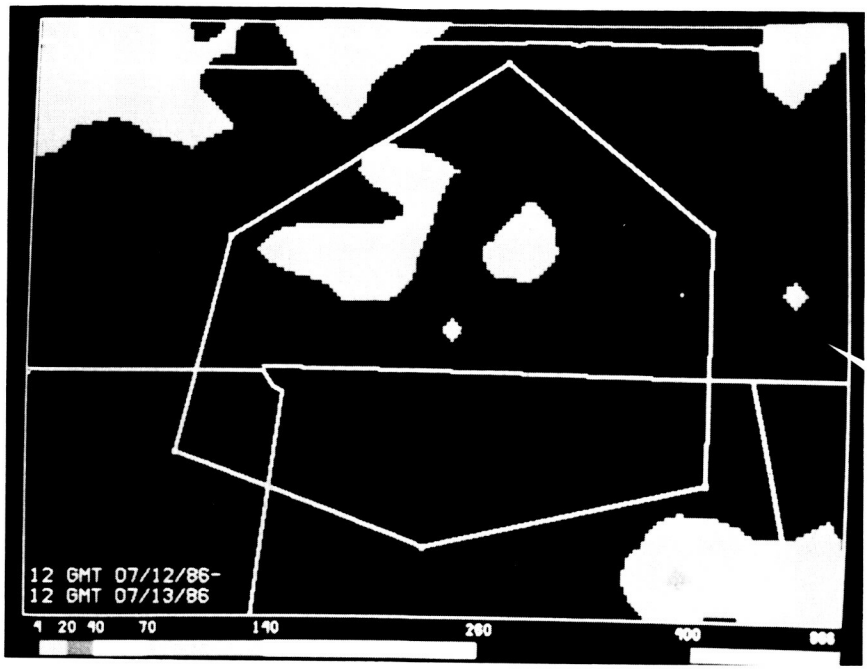


Fig. 3.2-41d. Twenty-four hour lightning strike density plot for 12-13 July 1986

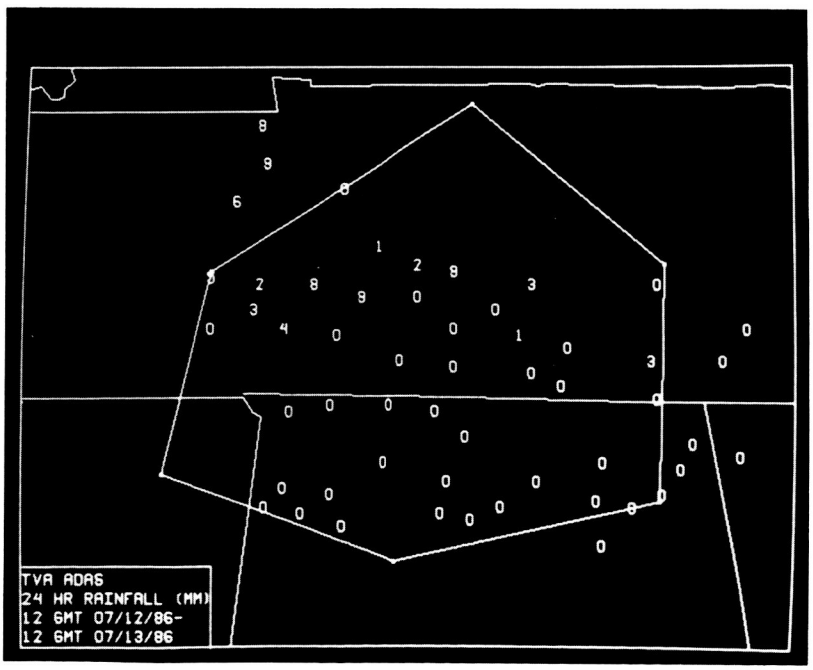


Fig. 3.2-41e. Twenty-four hour TVA ADAS rainfall totals (mm) for 12-13 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

13 July 1986

Synoptic Conditions

The upper level zonal flow showed signs of moving northward since yesterday morning. A short wave trough was located over northeast Arkansas and southeast Missouri at 1200 GMT. The RSA sounding at 1800 GMT revealed continued westerly flow, decreasing in strength from 650 to 400 mb. Easterly flow appeared since yesterday at upper levels. Precipitable water values increased slightly from yesterday. Convective instability also increased as slightly cooler air moved over the mesonet at middle levels in association with apparent lifting in advance of the short-wave trough. At the surface, temperature and dewpoint values over the mesonet were 31-33 °C and 21-23 °C respectively in the presence of 4-6 m s^{-1} westerly flow. Visible satellite pictures suggest some discontinuity within the PBL over the SPACE mesonet. This appeared to trigger initial convection that later organized into a well formed MCS.

Cloud/Precipitation Overview

This was a very active day, with precipitating convection starting by late morning and persisting over the SPACE network through midnight. By 1730 GMT, a 150 km long line of showers oriented west-southwest to east-northeast was located from HSV into southeast central Tennessee. This line formed from generally scattered activity that had developed in the HSV area by 1600 GMT. Secondary deep convective clouds formed over western and south-central Tennessee by 1800 GMT. The activity over western Tennessee very quickly formed a line of intense convection (oriented southwest to northeast) which moved south-eastward, merging with echoes forming in advance of it by 2000 GMT. After 2000 GMT, convection assumed an east-west linear structure over the MIST/FLOWS network. By 2300 GMT, a linear MCS had formed, with a convective line on the southern edge and a stratiform precipitation region up to 80 km wide along the northern edge. This line moved south of the SPACE network by 0300 GMT. Tertiary convective development occurred from 0300 past 0600 GMT just west of the MIST/FLOWS network.

Low level outflows were common with the convective activity, and microbursts (13 logged at FL-2) were detected in a large fraction of the stronger cells (peak wind of 29 m s^{-1}). Some convective cells attained tops of 16 km and reflectivities to 70 dBZ. The mature MCS exhibited apparent mesoscale updraft and downdraft regions, and a large anvil cloud extending ~150 km to the north of active convection. Rainfall amounts were general heavy over the southern 40% of the SPACE network. Some MIST/FLOWS PAM stations recorded rainfall rates exceeding 200 mm h^{-1} over 1-3 min time intervals.

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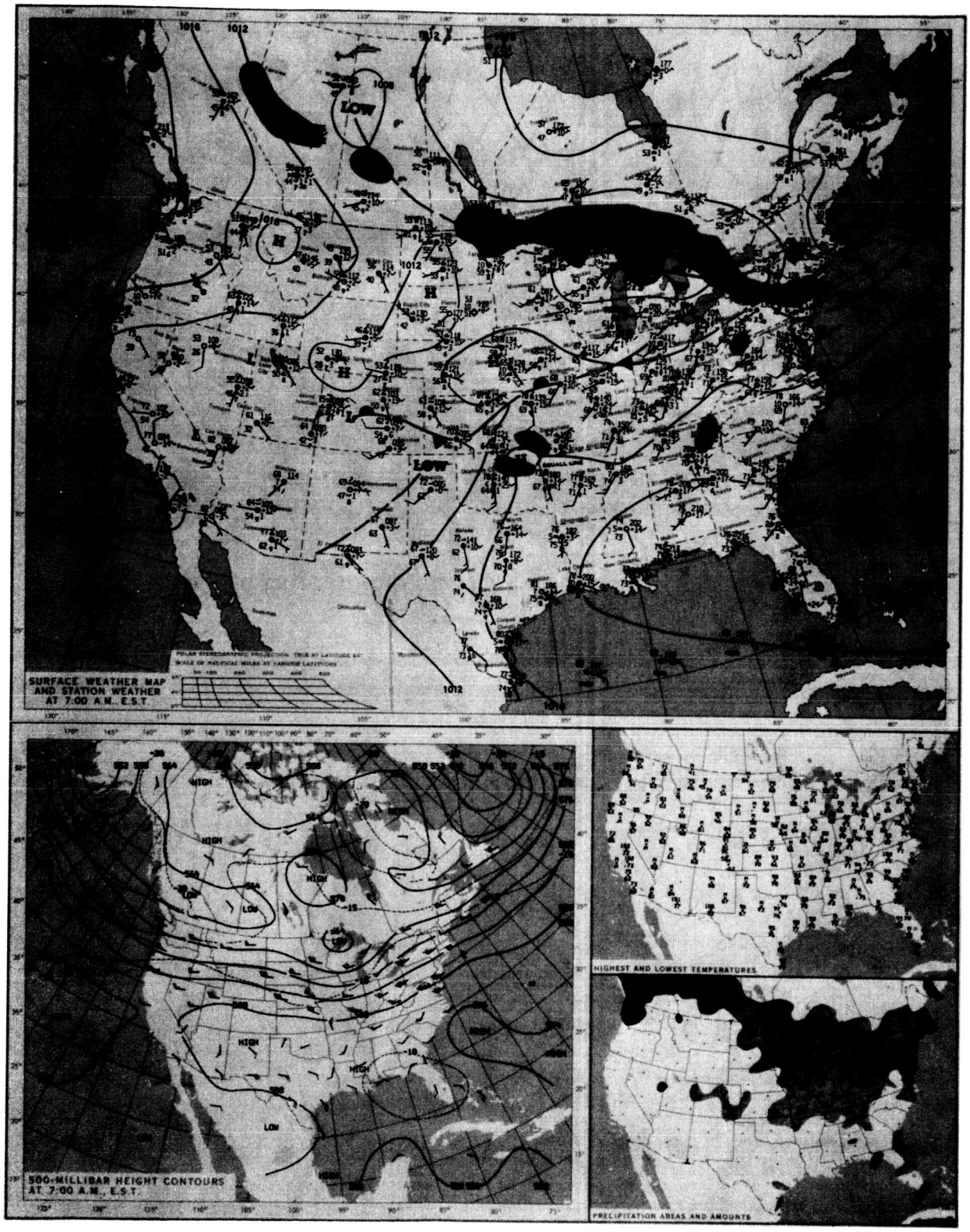


Fig. 3.2-42a. Synoptic weather conditions for 13 July 1986 1200 GMT

OPERATIONAL SUMMARY

13 July 1986

Rawinsonde Operations

Serial ascents were made from RSA/MSFC at 1200, 1800, 2100 and 2300 GMT. These should provide a good time cross section through the evolving MCS.

Radar Operations

Very good single and multiple Doppler data were acquired by all Doppler radars. Individual convective cells were well sampled as the convective line moved southward through the MIST/FLOWS network. VAD scans were conducted by CP-4 while the convective line moved overhead, and again for 80-min within the trailing stratiform precipitation. Overall, the MCS was very well sampled by radar.

Fl-2 personnel logged 13 microbursts, one exhibiting a maximum divergence of 34 m s^{-1}, and 5 gust fronts during the day. Both FL-2 and UND were operational during the evening activity. A number of gust fronts and one macroburst were observed during the evening hours.

Satellite Operations

GOES VAS products were acquired through 2230 GMT. In general, good sounding potential exists within generally clear region surrounding the afternoon MCS.

Aircraft Operations

Between 1830 and 2130 GMT, the Citation conducted 8 penetrations through the outflow boundaries of intense cells within the developing MCS. Wind shifts of up to 25 m s^{-1} were encountered across the outflow boundary.

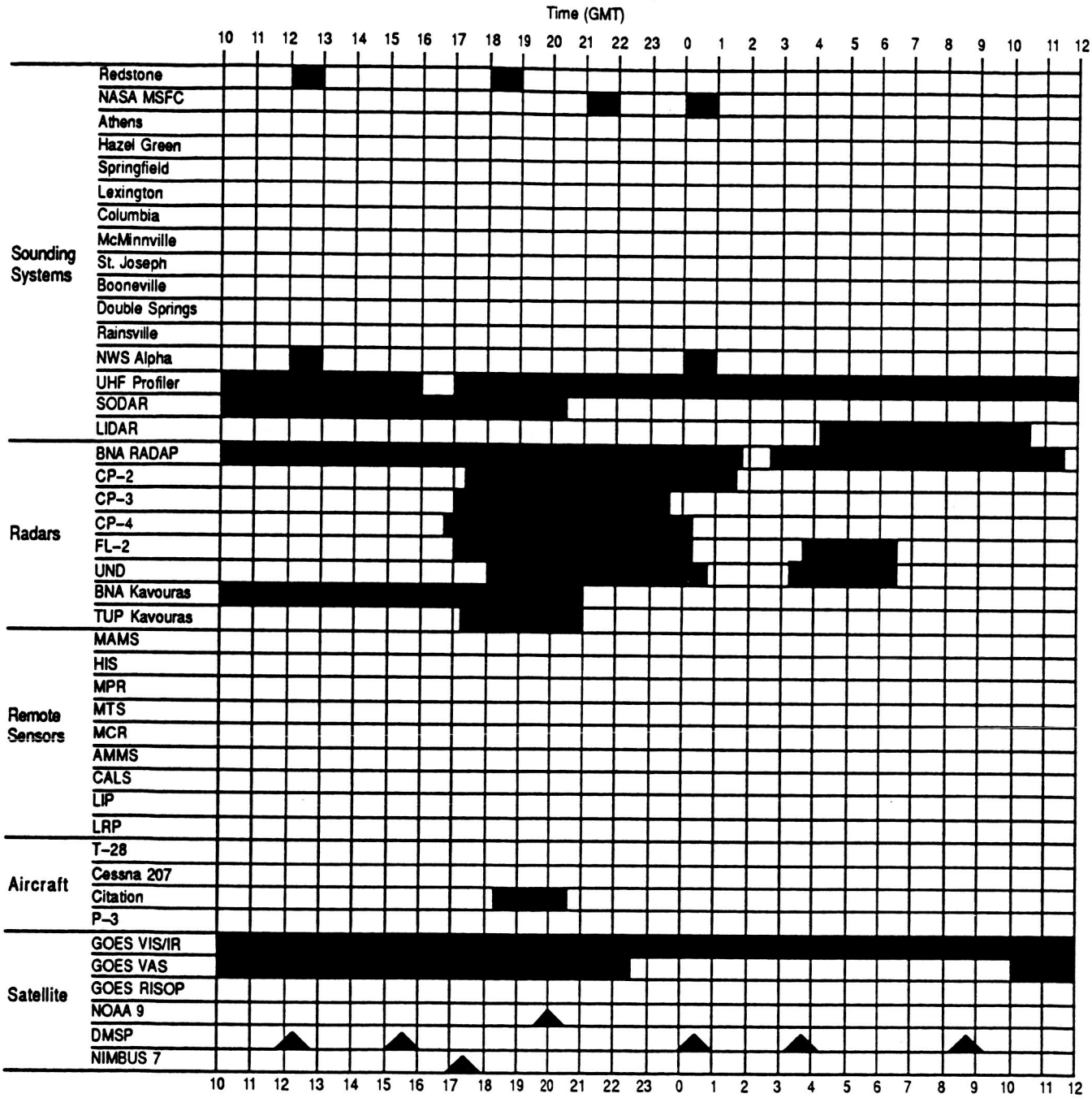
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5-550-7-8(42)

Day: SUNDAY
Date: 7/13/86
Julian Day: 194–195

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	OPERATIONAL
	TVA ADAS	MISSING STATIONS 12, 13, 16, 21, 32 & 56
	LLP	OPERATIONAL
	Mobile Lab	1800–0000 GMT

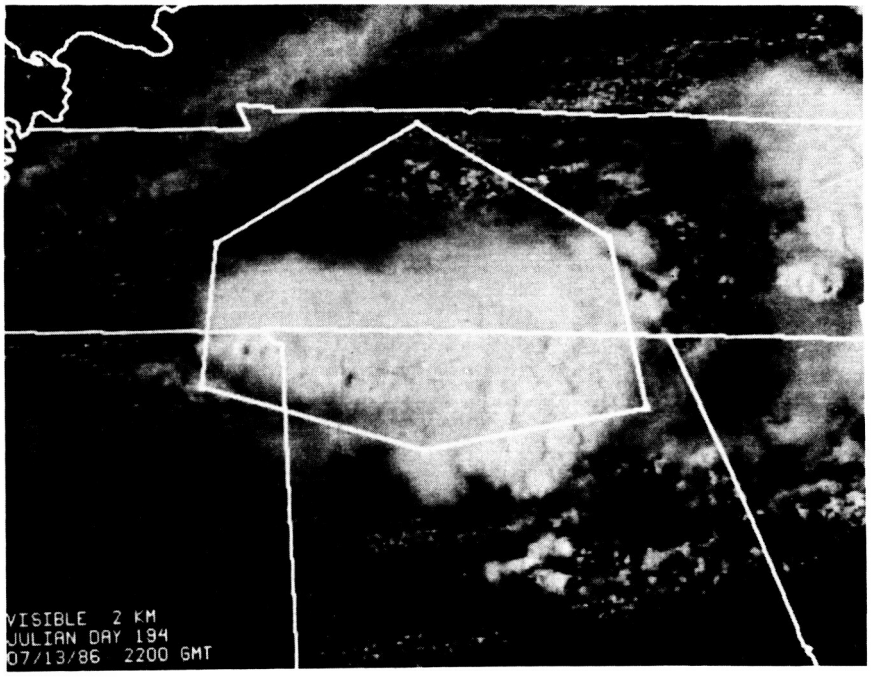


Fig. 3.2-42b. Visible 2 km GOES Central satellite image for 13 July 1986 2200 GMT

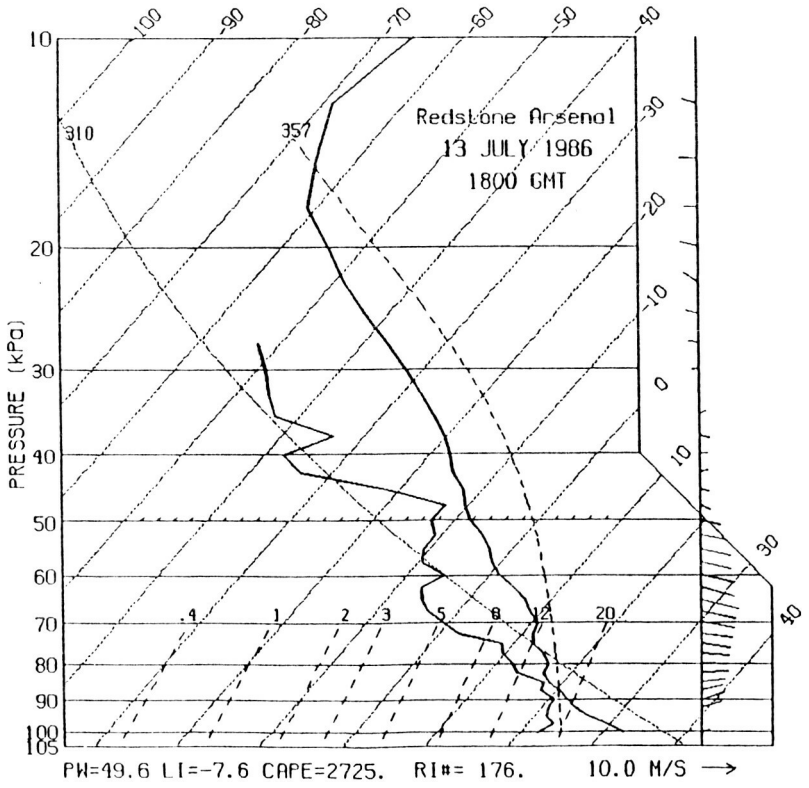


Fig. 3.2-42c. Redstone Arsenal, AL, rawinsonde sounding for 13 July 1986 1800 GMT

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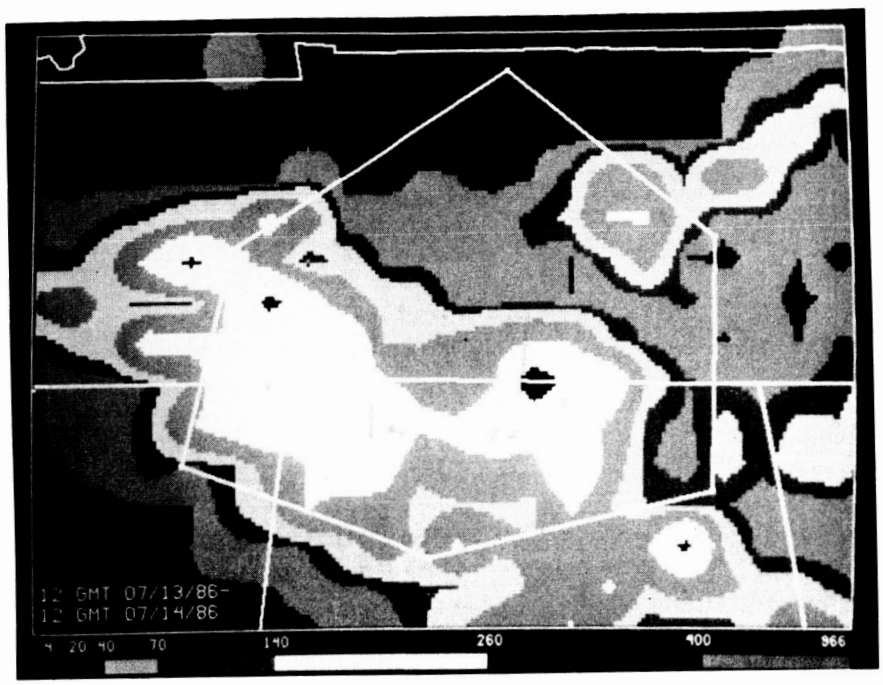


Fig. 3.2-42d. Twenty-four hour lightning strike density plot for 13-14 July 1986

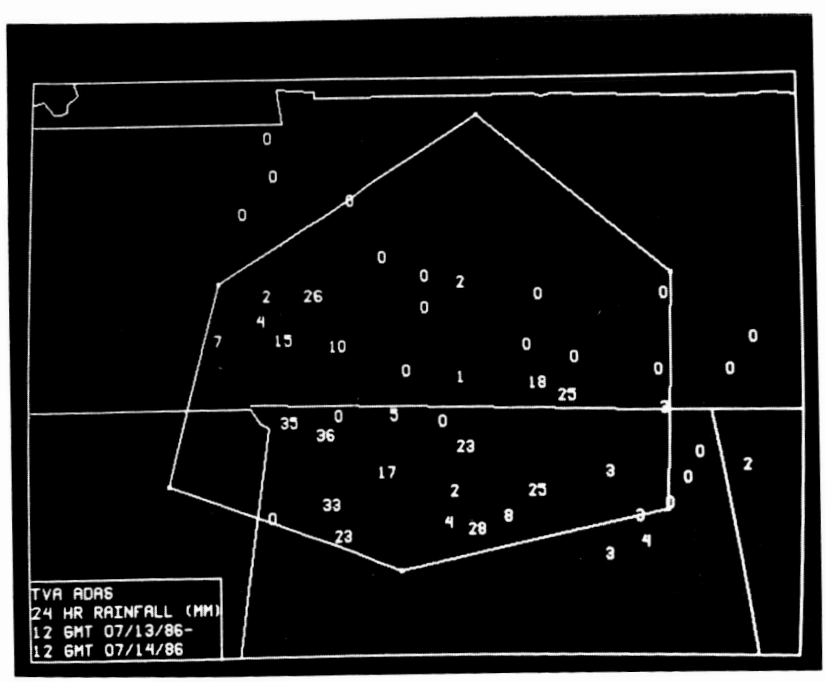


Fig. 3.2-42e. Twenty-four hour TVA ADAS rainfall totals (mm) for 13-14 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

14 July 1986

Synoptic Conditions

Regional scale environmental conditions above the PBL appear similar to those observed yesterday. Flow at low to middle levels remained approximately zonal below 500 mb. A cutoff anticyclone formed since yesterday morning over Arkansas. Although not visible on the 1200 GMT 500 mb analysis, there is suggestion from other analyses of a short wave trough that moved over the SPACE mesonet during the day. Considerable nonuniformity in temperature was apparent over the south-central SPACE mesonet, where yesterday's intense convection produced heavy precipitation and appreciable cool low level outflow. The 1800 GMT RSA sounding indicates some degree of low level stability within the PBL. The area of northern Alabama was in fact the last to experience deep convection during the afternoon hours. Afternoon surface temperature and dewpoint values over the SPACE mesonet were 31-32 °C and 21-23 °C respectively in the presence of westerly surface flow of 2-5 m s^{-1}.

Cloud/Precipitation Overview

Widespread intense thunderstorm activity developed over the entire Meso-beta network during the afternoon. Earliest intense activity occurred over the northern and eastern portion of the SPACE mesonet. Development over the southern portion of the network was delayed, apparently due to cooler and more stable low level air produced by yesterday's MCS. From 1700 to 2030 GMT, thunderstorms were generally scattered over the network, becoming more widespread after 2030 GMT. Echo intensities appeared to maximize around 2100 GMT, while echo coverage peaked between 2200 and 0000 GMT. Individual thunderstorms were intense, with tops often greater than 15 km, reflectivity factors exceeding 60 dBZ, and strongly diverging flow at upper and lower levels. Low level outflows affected every SPACE mesonet station. FL-2 personnel noted two microbursts (one which produced a 28 m s^{-1} radial velocity differential over 3 km) and three major gust fronts. Precipitation total amounts over the SPACE mesonet were generally only moderate.

Although thunderstorms were intense and widespread over the mesonet, an organized MCS consisting of convective components merged with a coherent band of anvil associated stratiform precipitation (as observed yesterday) never did appear. Only 20-40 km wide stratiform patches generally left over from previous convection were observed.

Notes:

14 July 1986

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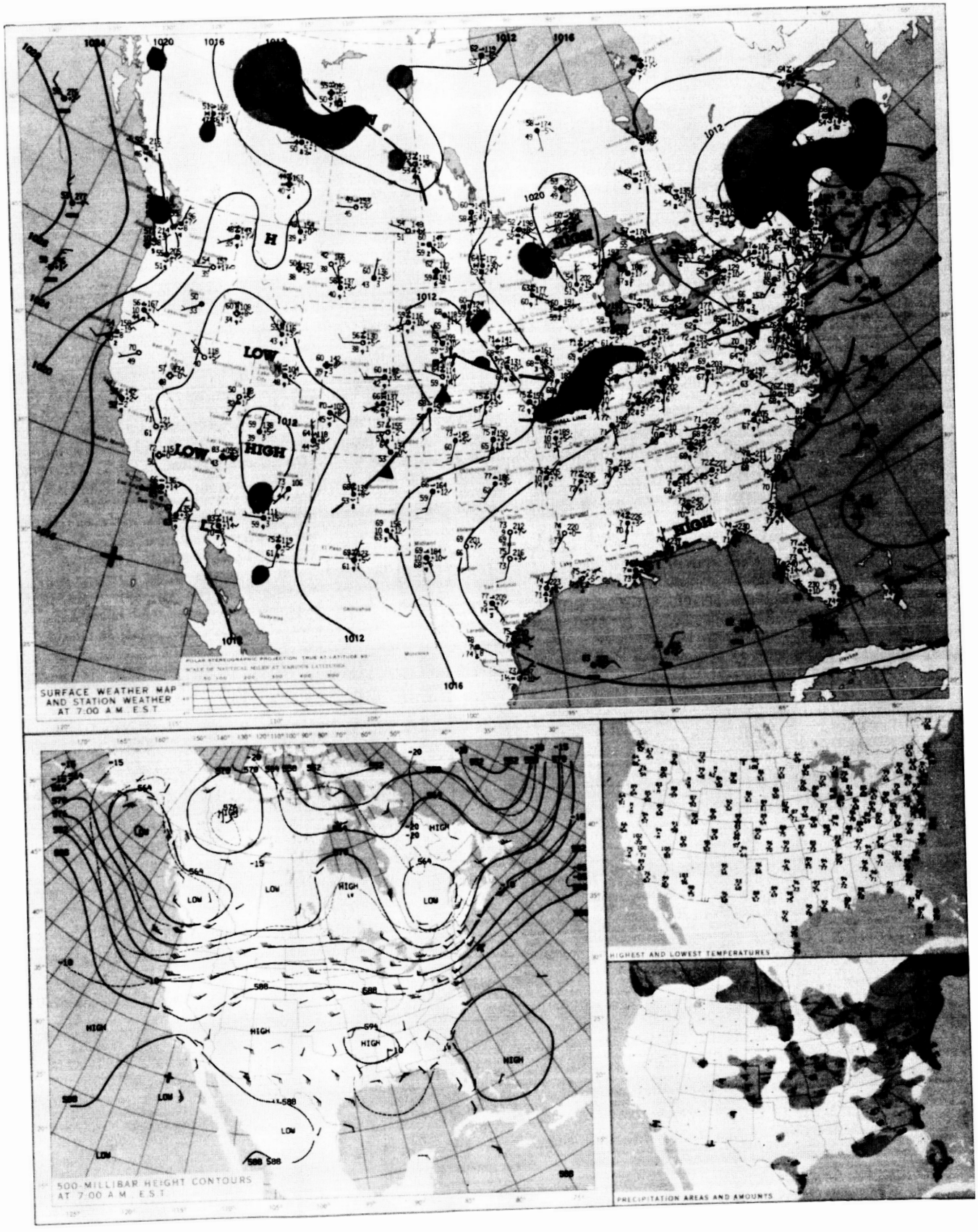


Fig. 3.2-43a. Synoptic weather conditions for 14 July 1986 1200 GMT

OPERATIONAL SUMMARY

14 July 1986

Rawinsonde Operations

A full Meso-beta rawinsonde operation was started at 1800 GMT, with balloons released every 3-h through 0600 GMT. Missed (important) releases include Rainsville (the southeast corner) at 2100 and 0000 GMT, and Hazel Green at and after 0000 GMT.

Radar Operations

CP-4 conducted primarily surveillance scans, with some RHI and PPI scans interlaced, from 1630 to 2315 GMT, after which CP-4 was inoperational due to power problems. CP-2 was very active, incorporating PPI and RHI scans primarily in support of the T-28, U-2 and ER-2 aircraft, and the mobile lab. Some coordinated dual Doppler scans were accomplished with CP-2 and CP-3 over and southeast of the MIST/FLOWS network from 1830 to 1930 GMT. CP-2 then operated independently after the dual Doppler coverage.

Satellite Operations

Normal GOES operations were run through 2130 GMT, after which RISOP was begun. The 0000 GMT DMSP satellite overpass occurred during a period of dual Doppler coverage.

Aircraft Operations

Four aircraft were operational, with three (the Citation, T-28 and U-2) sampling storms over the Meso-beta network during the afternoon hours. The U-2 (LRP) sampled storms primarily over the central beta network from 2130 to 0000 GMT (northwest of CP-2 60 - 100 km), receiving support from CP-2, the mobile laboratory and the T-28 aircraft. (The mobile lab measured very strong electric fields in one balloon launch).

The T-28 conducted six penetrations (from 2200 to 2250 GMT) through convective cores in advance of an intense line. One penetration was nearly simultaneous with a U-2 overflight near 2205 GMT. Measured liquid water amounts were generally large, and turbulence approached extreme levels.

From 2030 to 2300 GMT, the Citation conducted primarily low level penetrations of gust fronts, associated initially with intense individual cells located northeast of the MIST/FLOWS network. Subsequent measurements were acquired on a larger scale gust frontal system associated with intense convection and located northwest of the MIST/FLOWS mesonet. Finally, the ER-2 conducted a night-time mission (MAMS, HIS AMMS, MTS, MPR AND LIP) over southern Tennessee from 0245 to 0315 GMT(CP-2 support), and over northern Tennessee to southern Kentucky from 0300 to 0445 GMT.

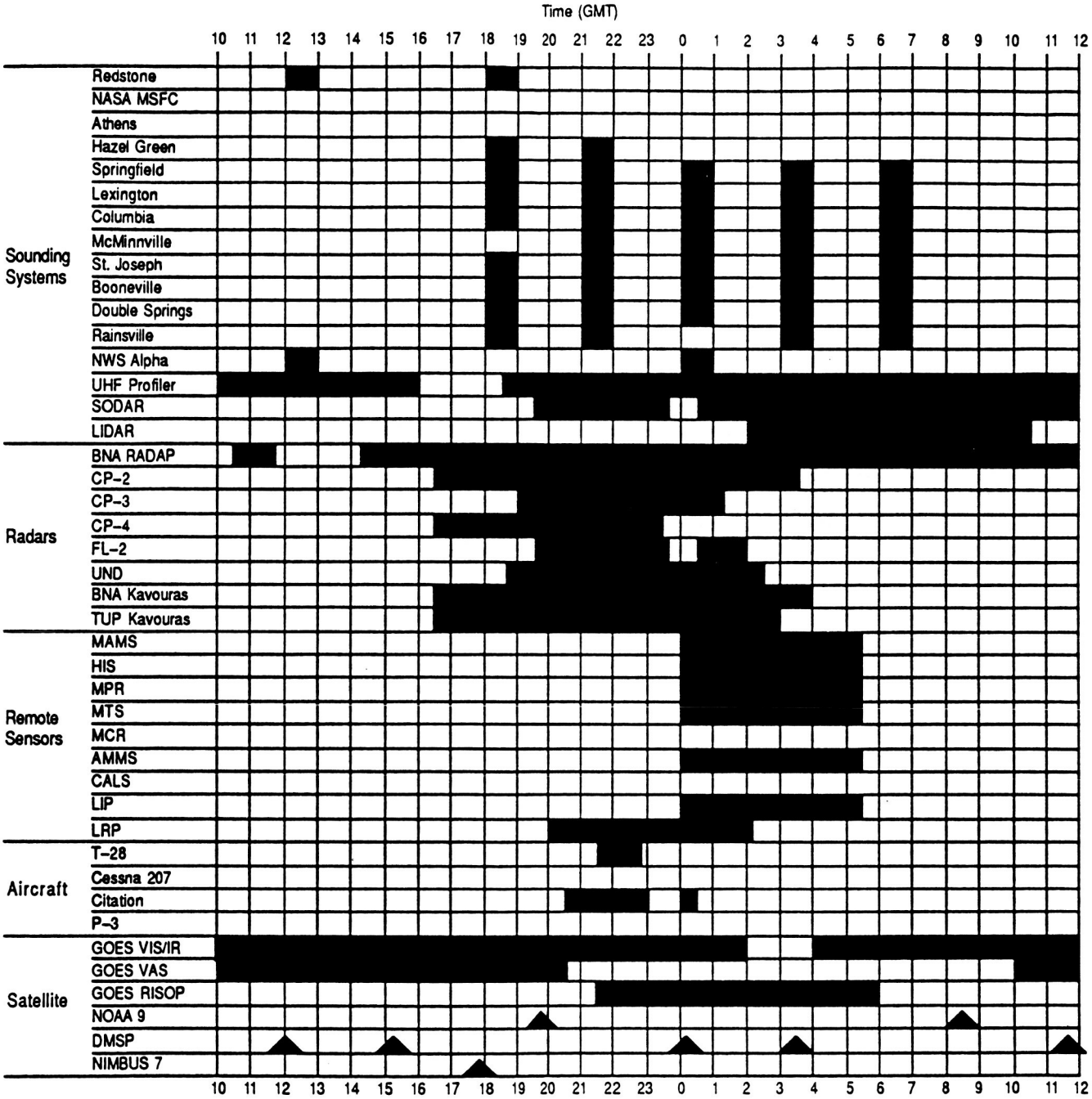
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5-550-7-8(43)

Day: MONDAY
Date: 7/14/86
Julian Day: 195–196

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	OPERATIONAL
	TVA ADAS	MISSING STATIONS 12, 13, 21, 45 & 56
	LLP	OPERATIONAL
	Mobile Lab	2000–0200 GMT; LAUNCHES

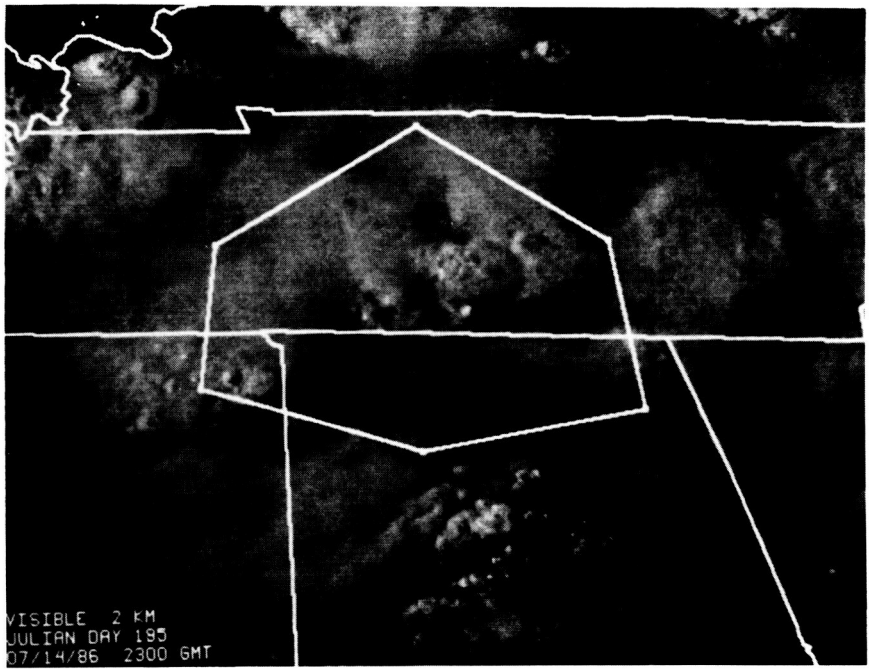


Fig. 3.2-43b. Visible 2 km GOES Central satellite image for 14 July 1986 2300 GMT

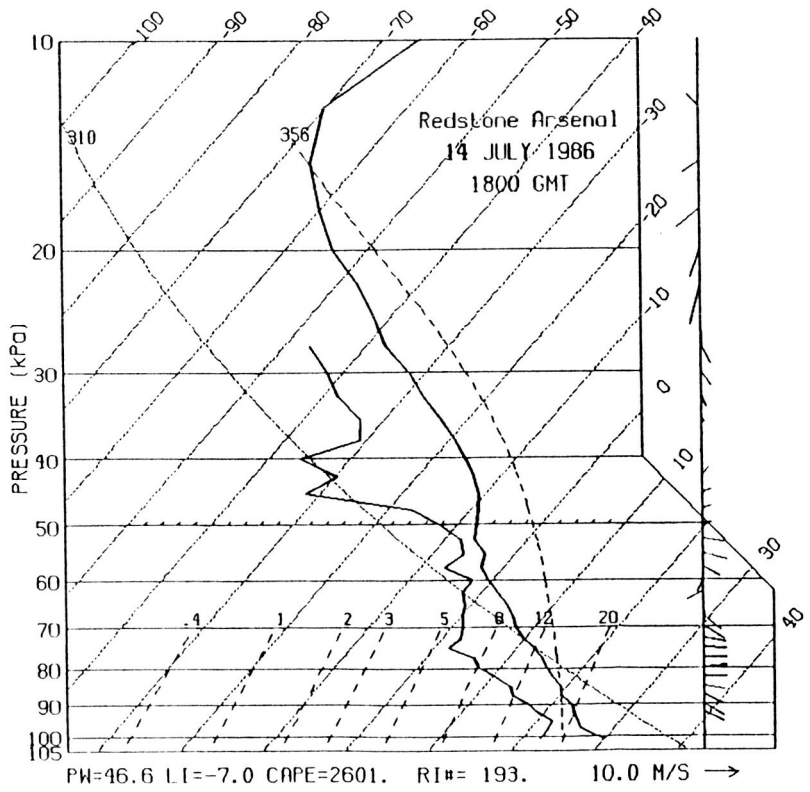


Fig. 3.2-43c. Redstone Arsenal, AL, rawinsonde sounding for 14 July 1986 1800 GMT

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Fig. 3.2-43d. Twenty-four hour lightning strike density plot for 14-15 July 1986

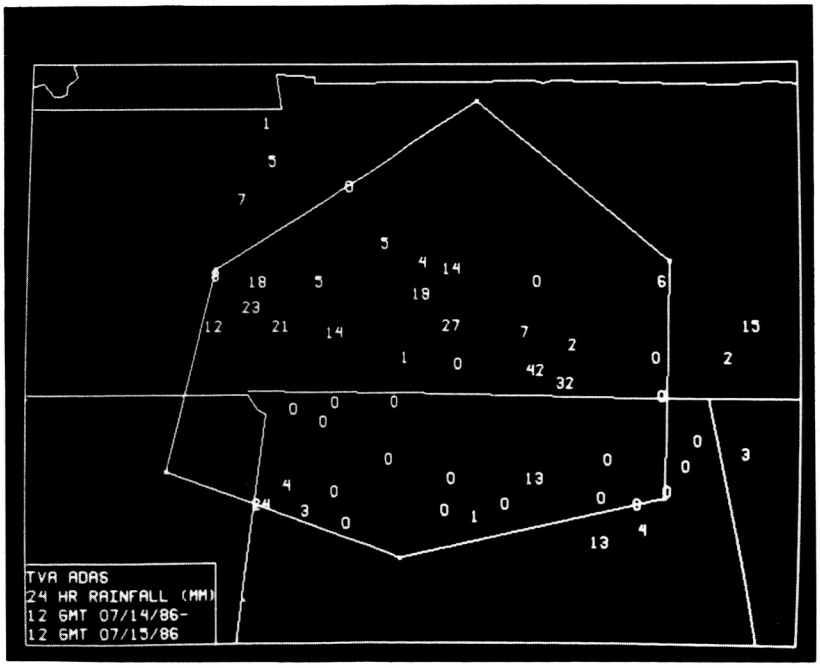


Fig. 3.2-43e. Twenty-four hour TVA ADAS rainfall totals (mm) for 14-15 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

15 July 1986

Synoptic Conditions

Winds aloft turned to a more northerly direction behind (or to the west of) a short wave trough that moved over the region yesterday. However, stabilization did not appear to take effect until the afternoon, when skies cleared over much of the southern SPACE mesonet. Precipitable water remained high on the 1800 GMT RSA sounding, which ascended through the anvil region of a small MCS. Afternoon values of surface temperature and dewpoint over the SPACE region showed variability in temperature, ranging from a cool 26 and 22 °C over the south to 32 and 22 °C over the northern network. Surface flow was south to southwesterly at 2-4 m s^{-1}.

Cloud/Precipitation Overview

General morning cloudiness existed over much of Alabama and Tennessee. A small (70 km diameter) MCS developed early over south central Tennessee (by 1200 GMT) and moved southward into northern Alabama by 1800 GMT. Very rapid system dissipation occurred after 1930 GMT. This MCS exhibited both a convective and uniform stratiform precipitation regions during its life cycle, which exceeded 7-h. Moderate amounts of precipitation (to 10 mm) and lightning were produced, and clearing was prominent within its wake along the northern edge. By late afternoon (2130 GMT), several isolated thunderstorms redeveloped just west of BNA over the northern SPACE mesonet.

Notes:

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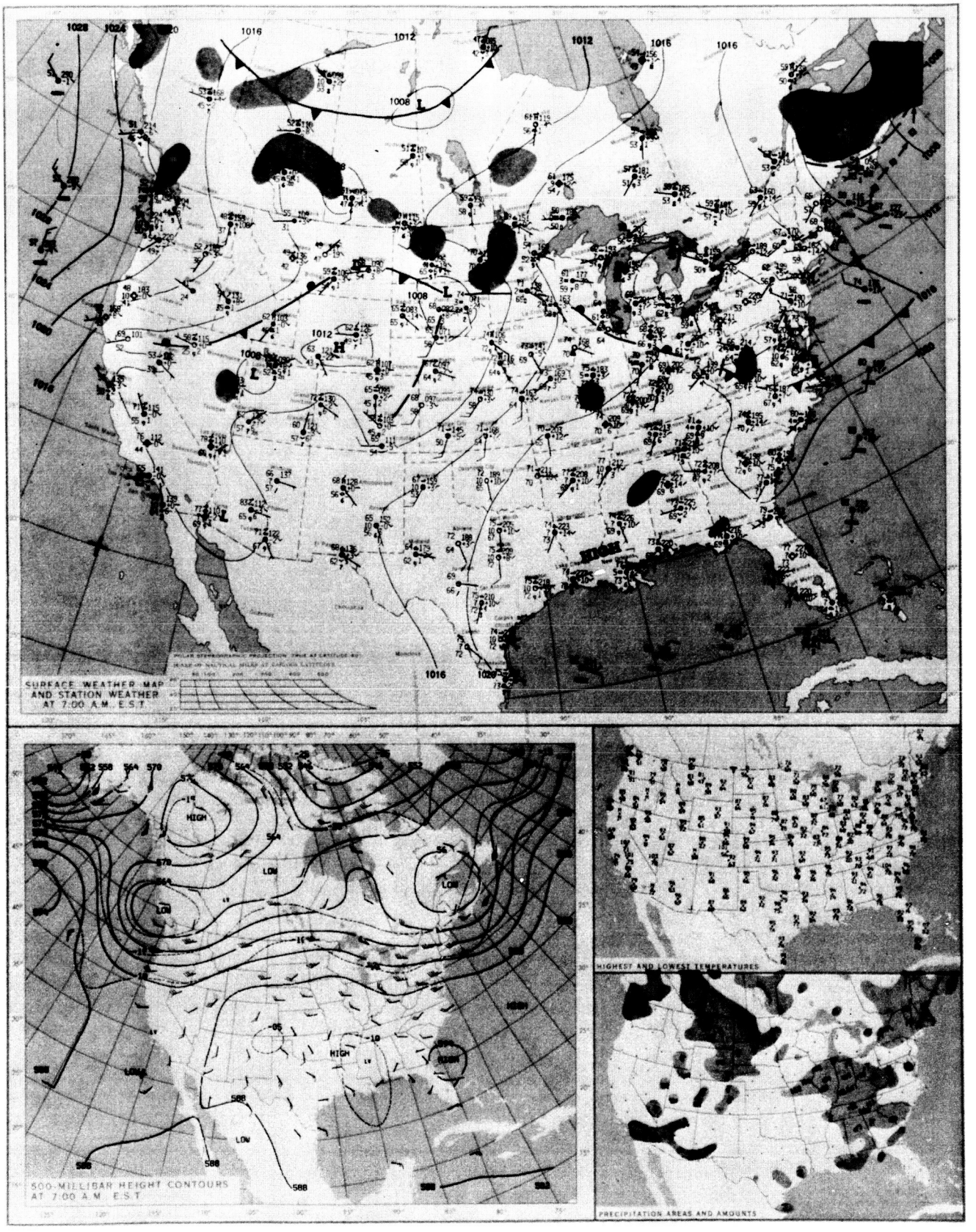


Fig. 3.2-44a. Synoptic weather conditions for 15 July 1986 1200 GMT

OPERATIONAL SUMMARY

15 July 1986

Rawinsonde Operations

A 9 station Meso-beta operation was conducted at 3-h intervals from 1800 to 0000 GMT. This time period encompasses the latter stage of the early MCS, and the initiation to mature stages of the late afternoon convection over the northern beta network. The 1200 GMT RSA sounding was not made because of equipment failure.

Radar Operations

The Doppler radars conducted miscellaneous scans on the early MCS. CP-4 conducted mostly VAD scans throughout while CP-2 emphasized sectored PPI and RHI scans. FL-2 implemented NEXRAD scans on the small MCS for 1-h as it moved over the MIST/FLOWS network.

Satellite Operations

Normal GOES operations were in effect all day. VAS data were acquired through 2030 GMT and should document horizontal variations at low levels that appeared to exist over the SPACE network.

Aircraft Operations

No operations.

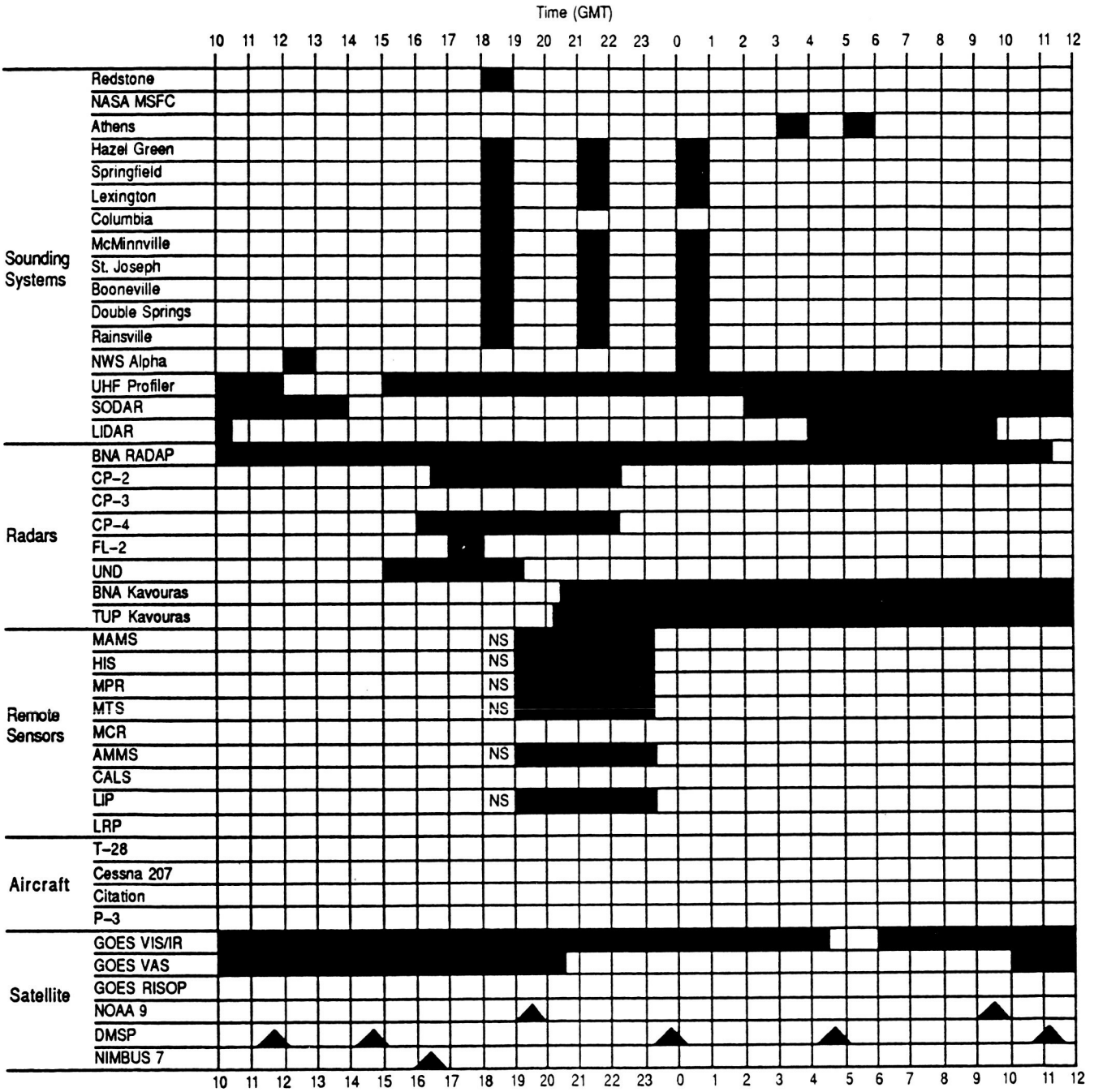
Notes:

5-550-7-8 (44)

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Day: TUESDAY
Date: 7/15/86
Julian Day: 196–197

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 16, 21, 30 & 56
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

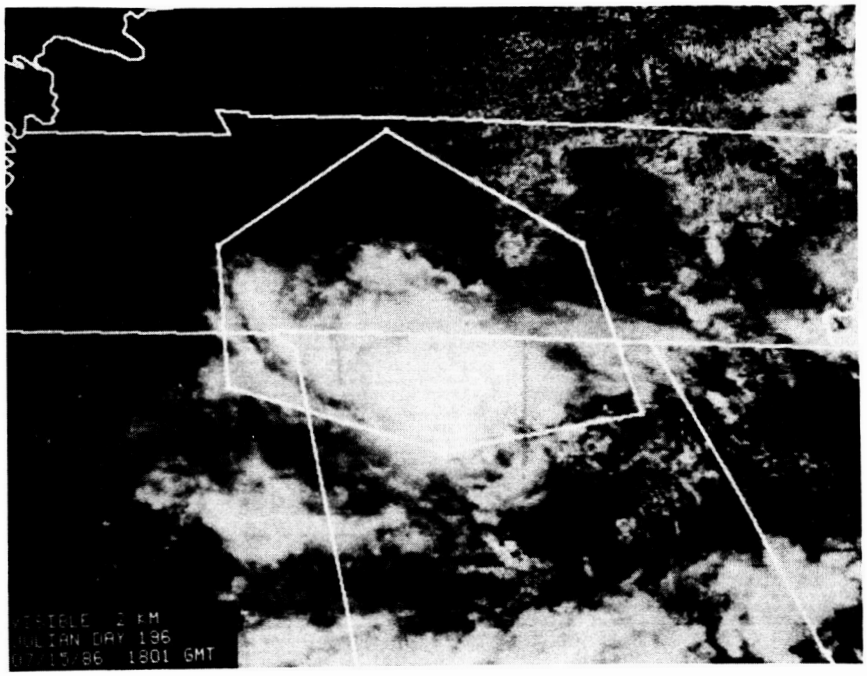


Fig. 3.2-44b. Visible 2 km GOES Central satellite image for 15 July 1986 1801 GMT

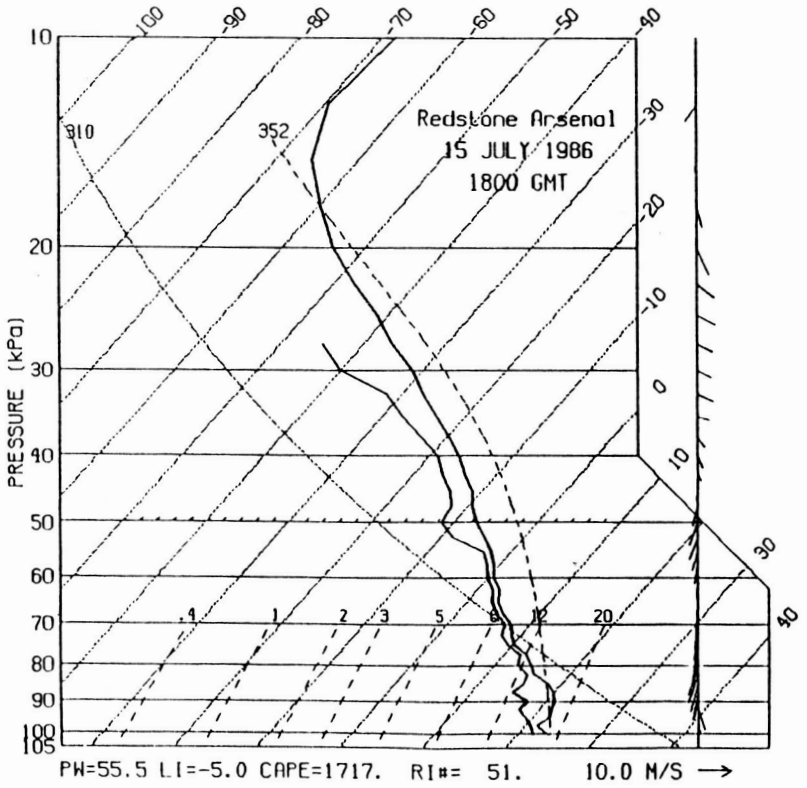


Fig. 3.2-44c. Redstone Arsenal, AL, rawinsonde sounding for 15 July 1986 1800 GMT

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Fig. 3.2-44d. Twenty-four hour lightning strike density plot for 15-16 July 1986

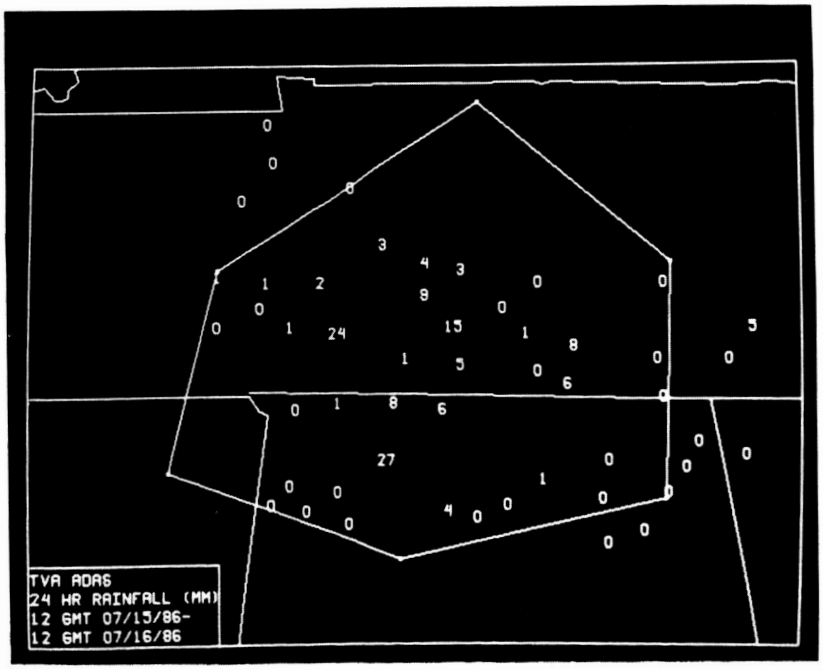


Fig. 3.2-44e. Twenty-four hour TVA ADAS rainfall totals (mm) for 15-16 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

16 July 1986

Synoptic Conditions

A deep anticyclone continued to develop over the Southeast. By 0000 GMT a cutoff center had formed over Kentucky, and the circulation around this produced easterly flow over the entire SPACE mesonet. Precipitable water remained high over northern Alabama, but the morning 6.7 micrometer water vapor image showed lower amounts of midlevel moisture over Tennessee. Static stability was low enough to permit scattered convection over the region. At the surface, afternoon temperature and dewpoint values were 34 and 19 °C, respectively, over the northeast mesonet and 32 and 21 °C over the southwest. Surface winds during the afternoon were westerly at 2-4 m s^{-1}.

Cloud/Precipitation Overview

Convective clouds formed earlier today, with cumulus congestus clouds observed around HSV by 1500 GMT. From morning to early afternoon, convection was favored over the Appalachian Mountains over east Tennessee. Several small cloud systems, each ~10 km in diameter, were observed around the MIST/FLOWS network. These generally appeared to be at best moderately intense kinematically (10-12 km tops), although reflectivity factor approached 65 dBZ in the core region. Cloud lifetimes were 30-45 min, and weak outflows and associated gust fronts were common. After 1930 GMT convective intensity over the SPACE mesonet declined, although one isolated thunderstorm cluster remained active over west central Tennessee from 1930 to 2130 GMT. Convection was more widespread and intense over central to south Alabama. One cloud that developed and evolved near Wheeler Lake from 1830 to 1930 GMT produced a moderately intense microburst over CP-3.

Notes:

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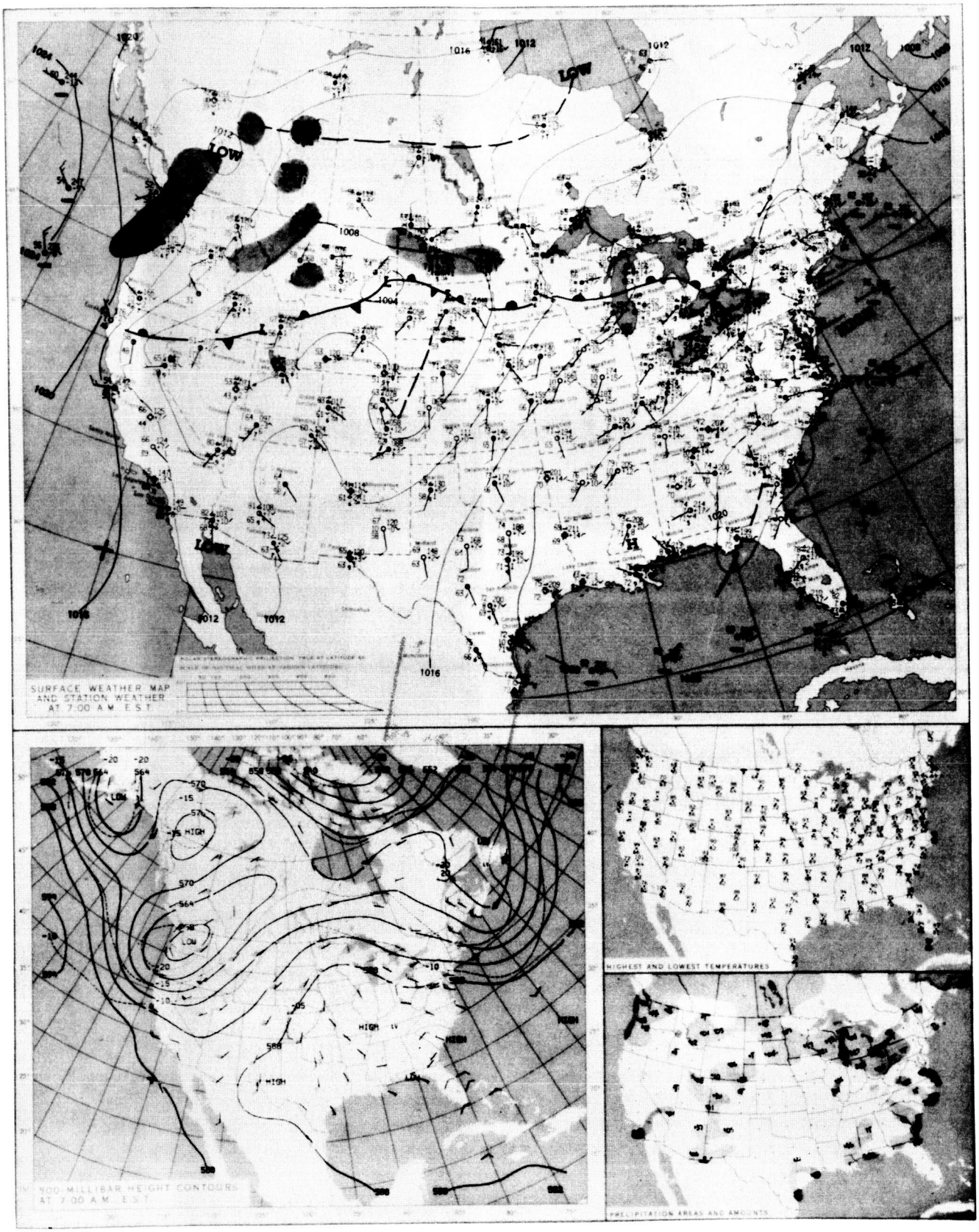


Fig. 3.2-45a. Synoptic weather conditions for 16 July 1986 1200 GMT

OPERATIONAL SUMMARY

16 July 1986

Rawinsonde Operations

The default 1200 and 1800 GMT RSA soundings were acquired.

Radar Operations

The NCAR Doppler radars completed dual Doppler scans on three clouds located over the western Doppler lobe. Limited scans were made on the first two cloud systems (1730-1750; 1755-1815; 1820-1830 GMT). A third cloud located near CP-3, was scanned from 1835 to ~1920 GMT. It appeared larger, was more vigorous, and produced a microburst. After 1930 GMT clouds over the MIST/FLOWS area dissipated and radars went into general surveillance mode. FL-2 was down during the afternoon hours for software installation, but did acquire some clear air ground clutter data in the morning.

Satellite Operations

GOES VAS products were acquired through 2130 GMT.

Aircraft Operations

The T-28 conducted a short flight, making some penetrations of weak convection located over the western beta network at ~2245 GMT.

Notes:

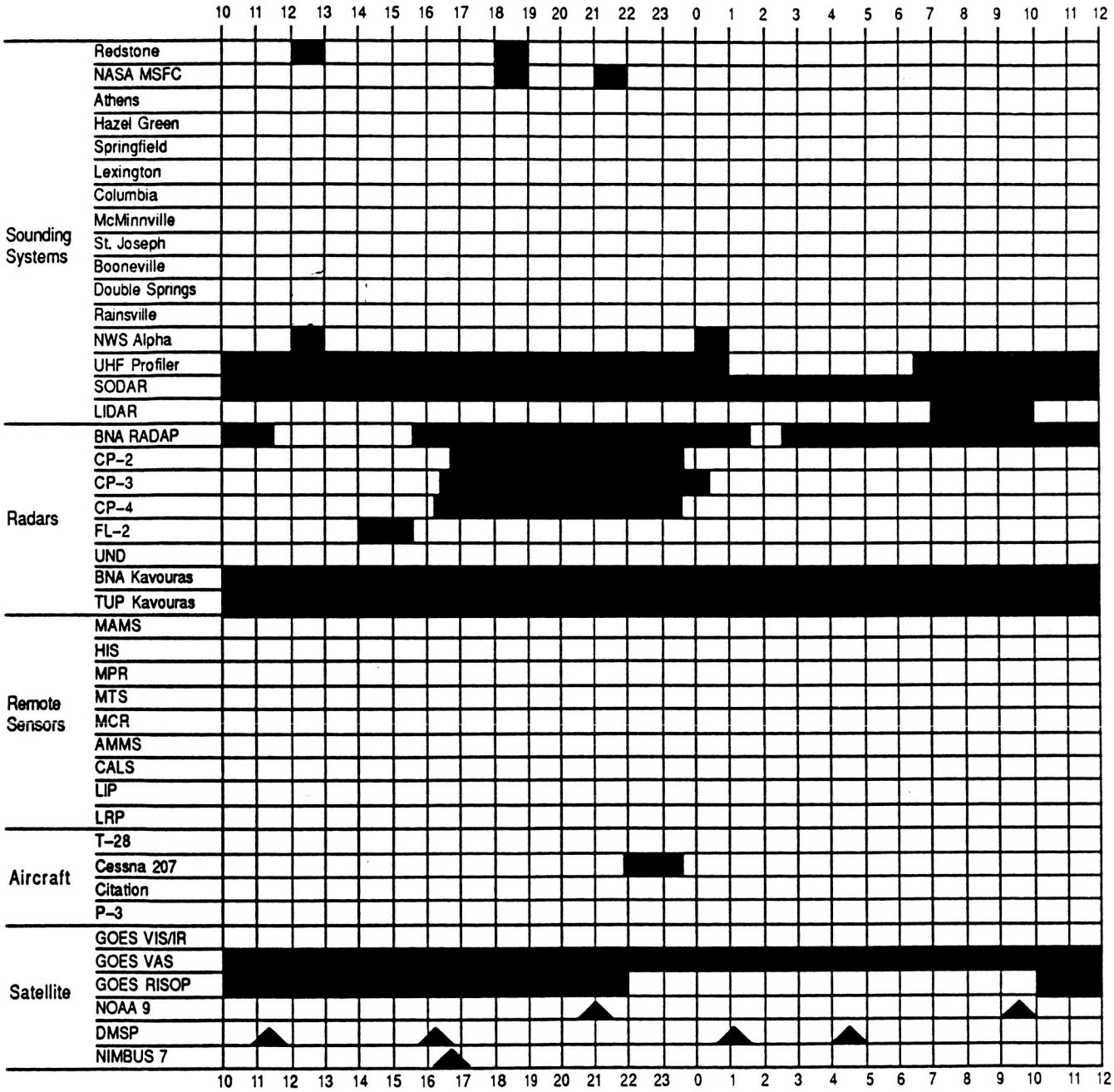
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5-550-7-8(45)

Day: WEDNESDAY
Date: 7/16/86
Julian Day: 197–198

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 16, 21, 30 & 56
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

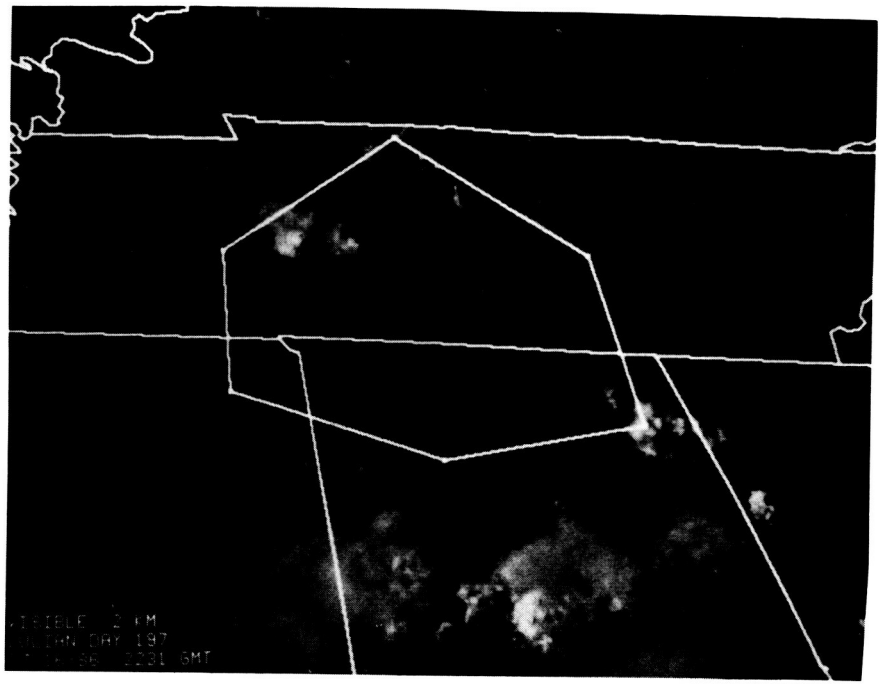


Fig. 3.2-45b. Visible 2 km GOES Central satellite image for 16 July 1986 2231 GMT

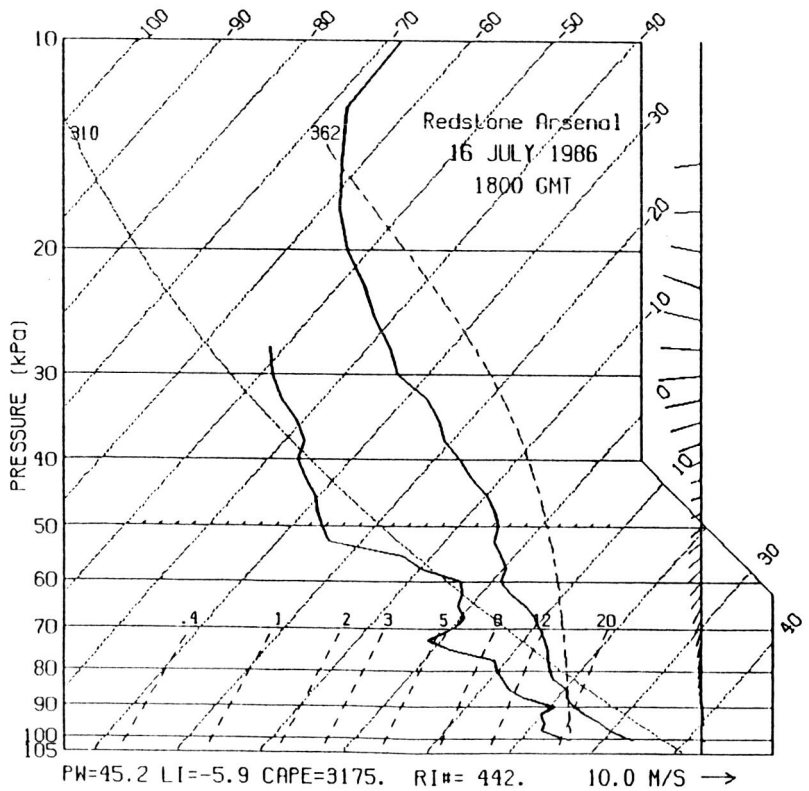


Fig. 3.2-45c. Redstone Arsenal, AL, rawinsonde sounding for 16 July 1986 1800 GMT

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Fig. 3.2-45d. Twenty-four hour lightning strike density plot for 16-17 July 1986

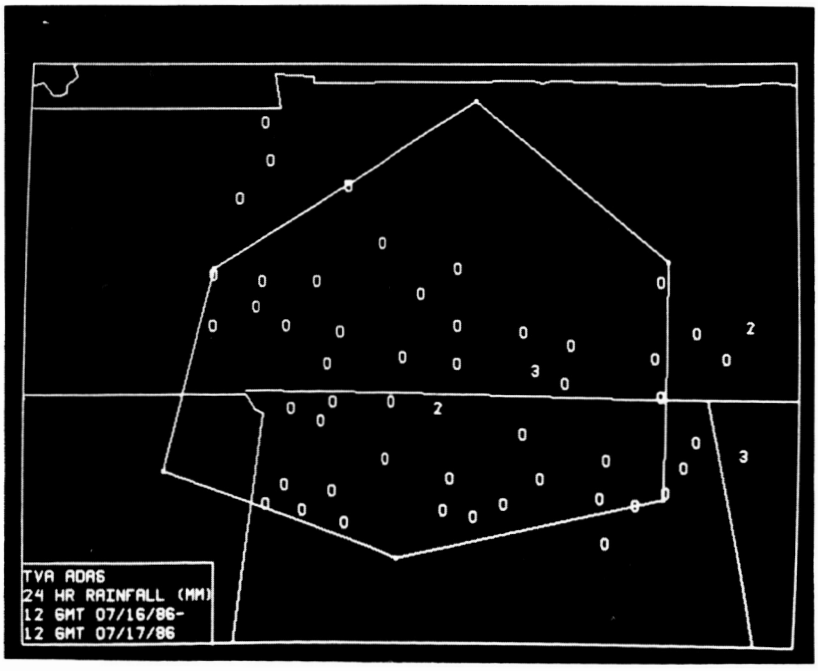


Fig. 3.2-45e. Twenty-four hour TVA ADAS rainfall totals (mm) for 16-17 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

17 July 1986

Synoptic Conditions

Easterly low shear flow continued around a deep cutoff anticyclone located over Kentucky. The 1800 GMT sounding appeared to have destabilized somewhat from yesterday as middle levels cooled 1-2 °C. However, a stable layer near 700 mb was still present. The morning 6.7 micrometer water vapor image showed little horizontal variation in middle level moisture over the SPACE mesonet. At the surface, flow over the entire Southeast was weak and generally anticyclonic around a diffuse high pressure region centered over southern Louisiana. Over the SPACE mesonet, afternoon surface temperature and dewpoint values were relatively uniform at 32-34 and 21-23 °C, respectively. Surface flow was north to northeasterly at 2-4 m s^{-1}.

Cloud/Precipitation Overview

Thunderstorms developed quickly by 1600 GMT over the central SPACE mesonet. At 1640 GMT five individual echo complexes had formed a line oriented southwest to northeast. Subsequently, an organized outflow developed and then moved radially from central Tennessee towards the south and west. By 1800 GMT, an east-west line of intense echoes existed over south-central Tennessee, but weakened thereafter. Individual cells exhibited tops to >12 km and reflectivity factor in excess of 55 dBZ. However, the large scale outflow visible on radar continued to initiate convection as it moved southward. By 2000 GMT, the strongest convective activity was located over northwest Alabama to southwest Tennessee. (This complex was initiated by the outflow boundary, which eventually passed over the MIST/FLOWS network). The northwest Alabama convective area remained active from 1930 to 2200 GMT. Cells within this system also exhibited tops and reflectivities exceeding 12 km and 55 dBZ, respectively. Finally a larger scale MCS developed over the extreme southeast SPACE mesonet by 2000 GMT and remained active until ~0300 GMT.

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17 July 1986

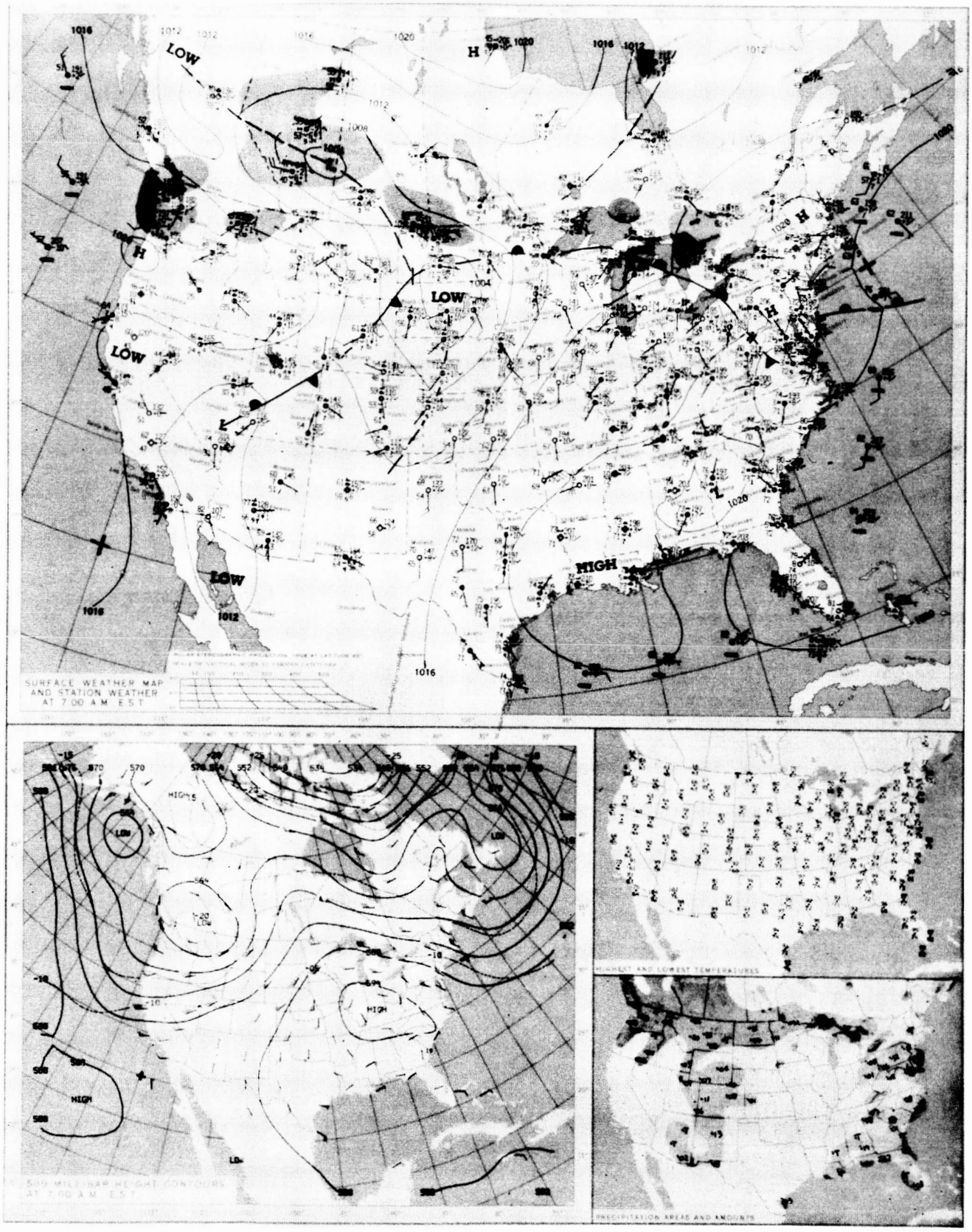


Fig. 3.2-46a. Synoptic weather conditions for 17 July 1986 1200 GMT

OPERATIONAL SUMMARY

17 July 1986

Rawinsonde Operations

The 1200 and 1800 GMT RSA soundings represent the only special releases.

Radar Operations

Miscellaneous scans were conducted on the convective systems over both central Tennessee and northwest Alabama. CP-4 provided the usual surveillance scans, while CP-2 effected primarily PPI and RHI scans of selected targets. The northwest Alabama system was well covered by radar throughout its evolution. Several multiple Doppler scans were effected on a short-lived cell which developed west of CP-2 along a large scale outflow boundary from 1930 to 1945 GMT. Although FL-2 was again down part of the afternoon for software work, some limited measurements were acquired on a gust front located over the western MIST/FLOWS mesonet.

Satellite Operations

GOES VAS products were collected through 2000 GMT, after which RISOP was started. The RISOP segment will therefore cover the mature to dissipating stages of the northwest Alabama system.

Aircraft Operations

The Citation acquired measurements around 1930 GMT on the outflow boundary generated by initial deep convection over Tennessee. It then flew southwest and worked the convective system over southwest Tennessee to northwest Alabama from ~2000 to 2130 GMT. The ER-2 also conducted one overflight of this second system and then returned prematurely. Ground-truth support was provided by the mobile lab from 2000 to 2130 GMT.

Notes:

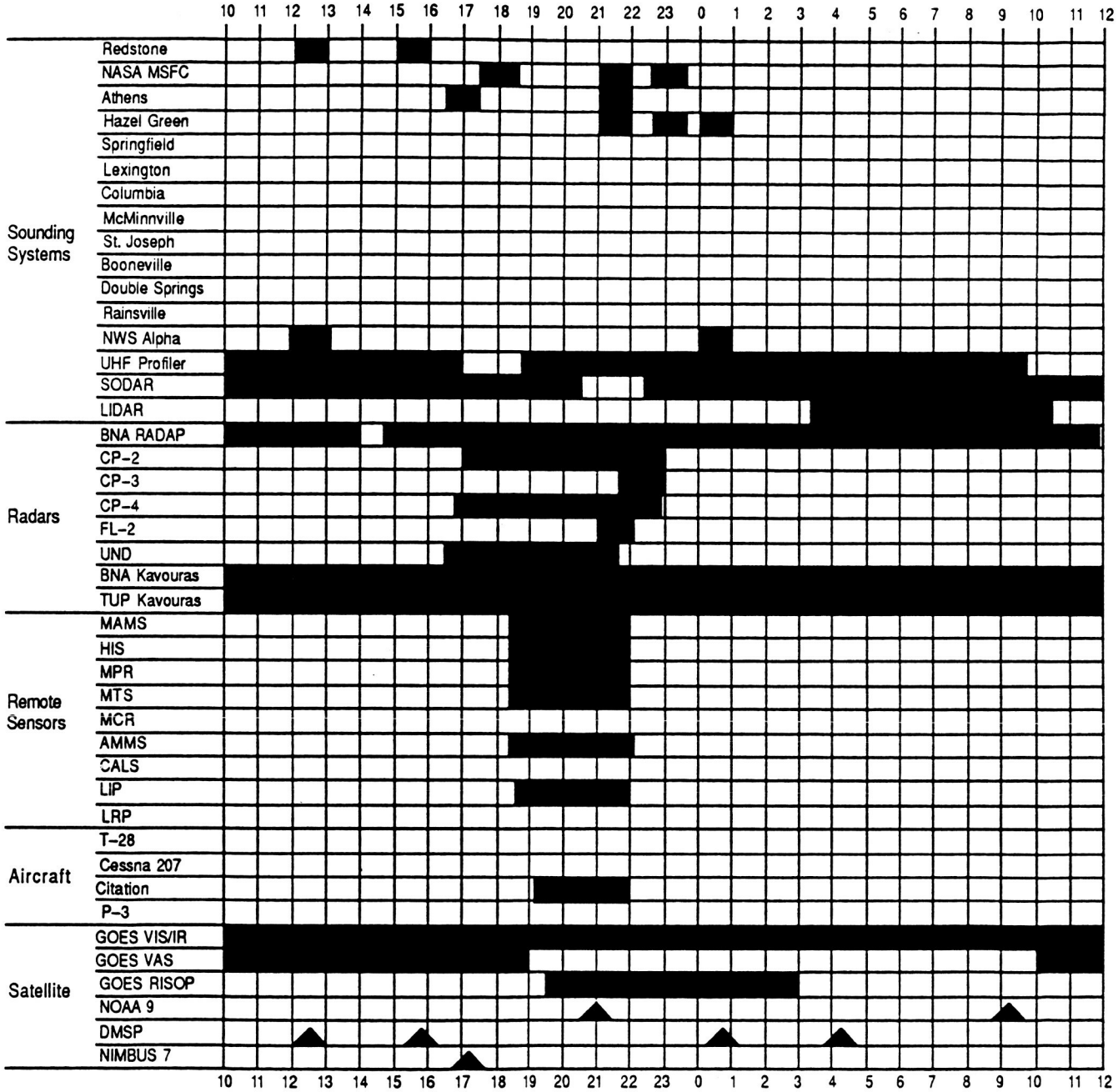
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5-550-7-8 (46)

Day: THURSDAY
Date: 7/17/86
Julian Day: 198–199

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 5, 16, 21, 26, 45, 56, & 59
	LLP	OPERATIONAL
	Mobile Lab	2015–2115 GMT; BALLOON LAUNCH

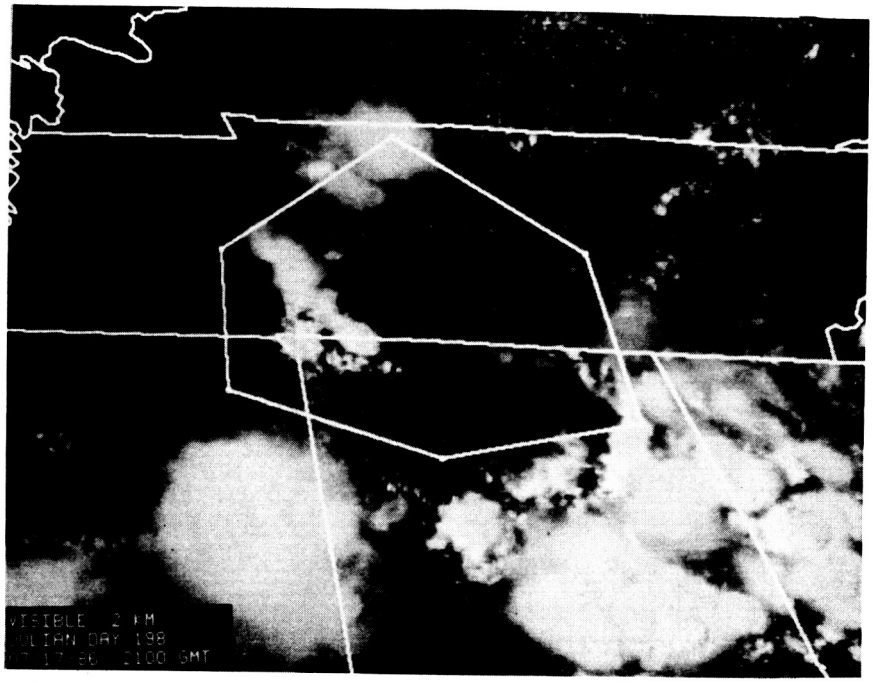


Fig. 3.2-46b. Visible 2 km GOES Central satellite image for 17 July 1986 2100 GMT

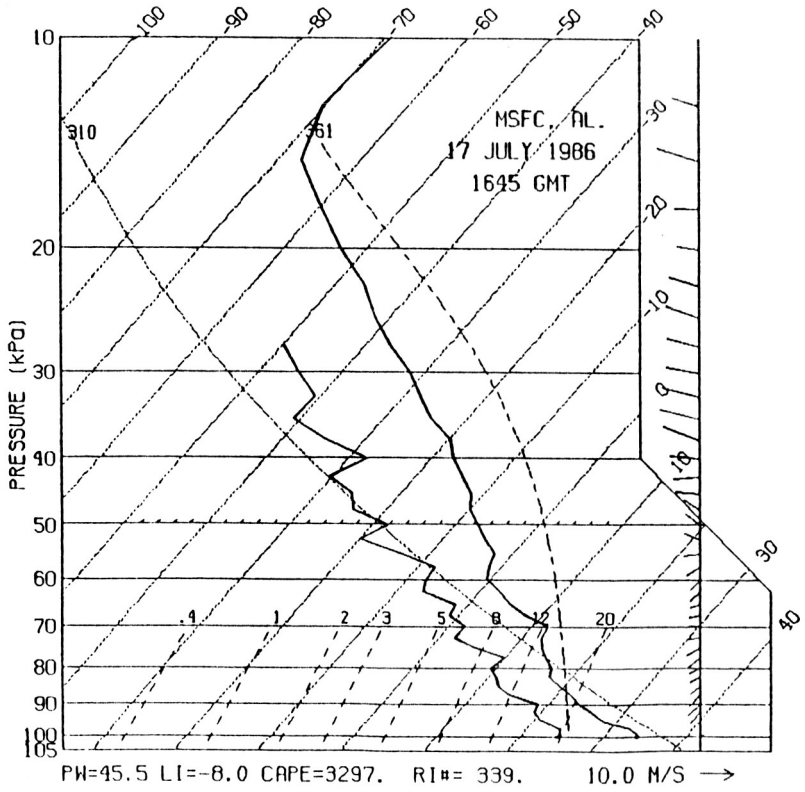


Fig. 3.2-46c. MSFC, AL, rawinsonde sounding for 17 July 1986 1645 GMT

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Fig. 3.2-46d. Twenty-four hour lightning strike density plot for 17-18 July 1986

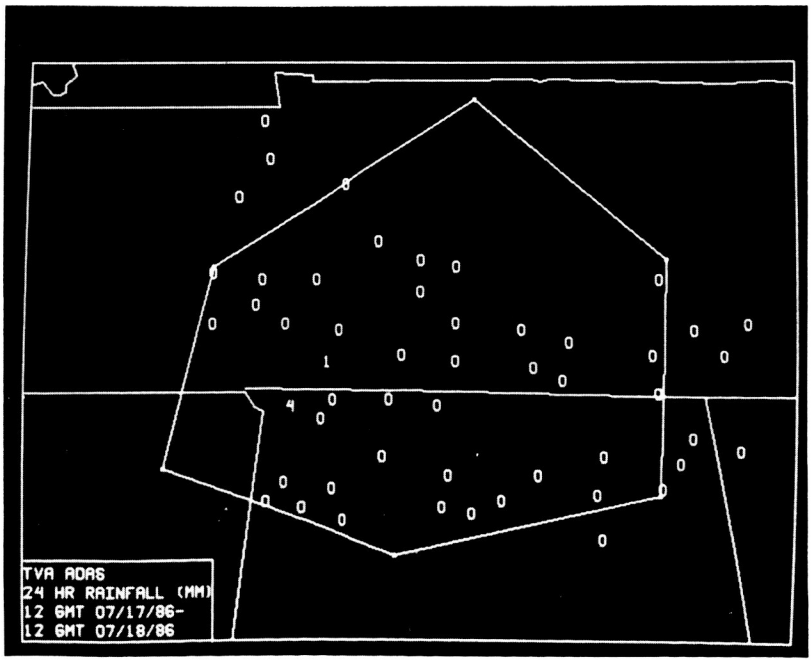


Fig. 3.2-46e. Twenty-four hour TVA ADAS rainfall totals (mm) for 17-18 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

18 July 1986

Synoptic Conditions

The deep anticyclone present over the Southeast on previous days continued to amplify and expand to a maximum strength and area today. This cutoff feature produced easterly flow aloft over the entire Southeast. Over the SPACE mesonet, flow veered from very light northeasterly at low levels to 10 m s ^{1} southeasterly near 250 mb. The atmosphere at lower to middle levels contained uniformly high moisture over the mesonet. Midlevel temperatures showed about 2 °C warming over yesterday, but total buoyant energy remained high at ~2700 J kg^{-1}. Afternoon surface conditions over the SPACE mesonet were relatively uniform, with temperatures of 32-34 °C and dewpoints of 21-23 °C. Surface winds were north to easterly at 2-4 m s^{-1}.

Cloud/Precipitation Overview

Isolated deep convection was observed over the extreme southern to southwestern, and north central portions of the SPACE mesonet. The southern most area of convection formed a broken east-west line at maturity. Echo intensity of cells within this line peaked in intensity around midafternoon. Cells over the north central region formed and intensified during the middle to late afternoon hours (after 2030 GMT). Elsewhere, isolated, weak and short-lived echoes were observed, including some near the MIST/FLOWS network. All activity weakened by early evening.

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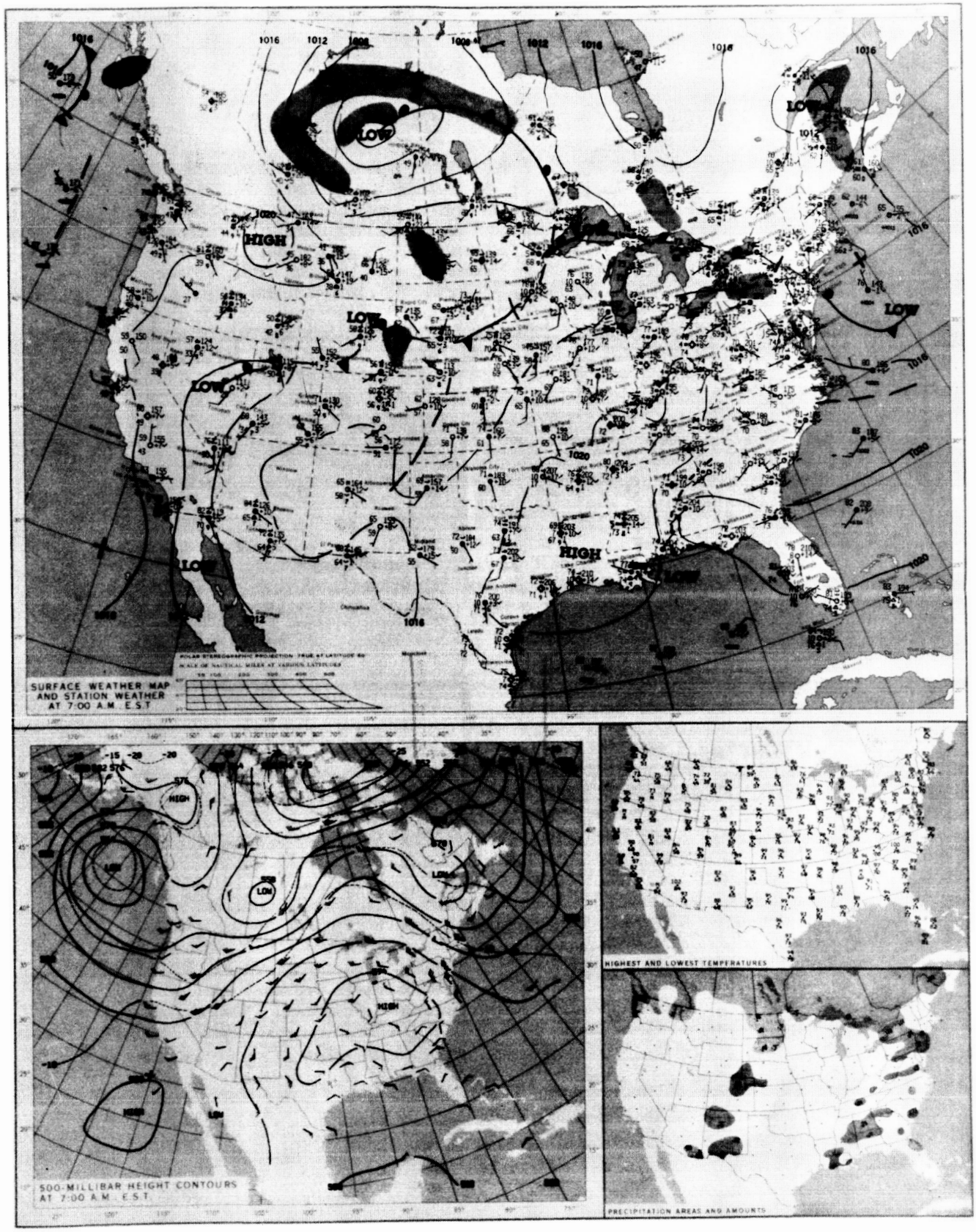


Fig. 3.2-47a. Synoptic weather conditions for 18 July 1986 1200 GMT

OPERATIONAL SUMMARY

18 July 1986

Rawinsonde Operations

A full Meso-beta rawinsonde operation was conducted at 3-h intervals from 1500 to 0230 GMT.

Radar Operations

A multiple Doppler study was conducted on a weakly precipitating cloud (tops to ~6 km) located over the western Doppler lobe, for about 30-min centered on 1800 GMT. Afterwards, CP-4 conducted surveillance scans, and CP-2 implemented miscellaneous scans, including 1/2 PRF long-range surveillance scans, on selected targets.

Satellite Operations

GOES VAS products were generated up to 2230 GMT, after which RISOP was begun.

Aircraft Operations

No operations.

Notes

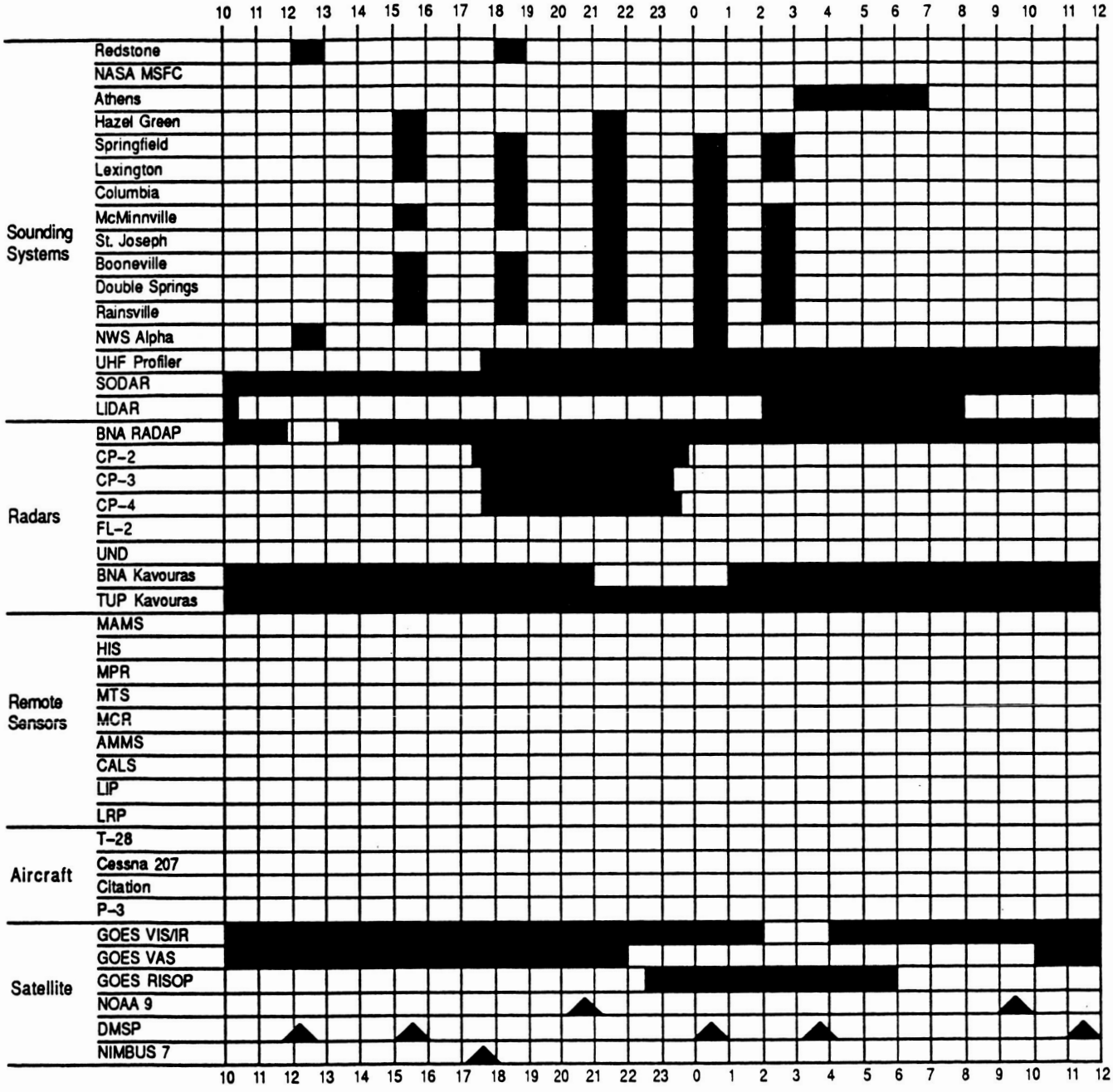
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5-550-7-8(47)

Day: FRIDAY
Date: 7/18/86
Julian Day: 199–200

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	DISK CRASH; SOME DATA NOT AVAILABLE
	FAM	OPERATIONAL
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 5, 45, 56 & 59
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

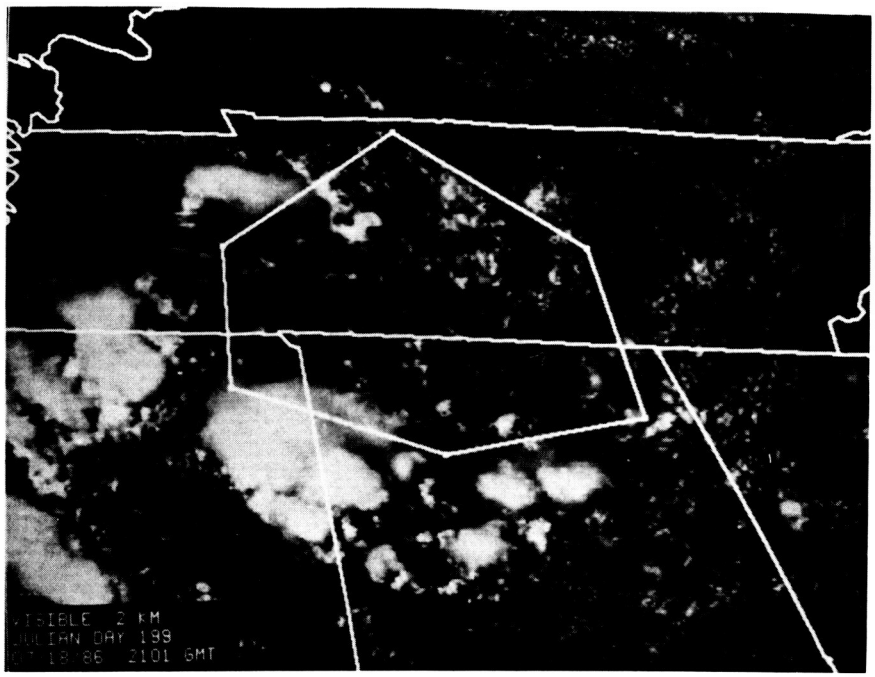


Fig. 3.2-47b. Visible 2 km GOES Central satellite image for 18 July 1986 2101 GMT

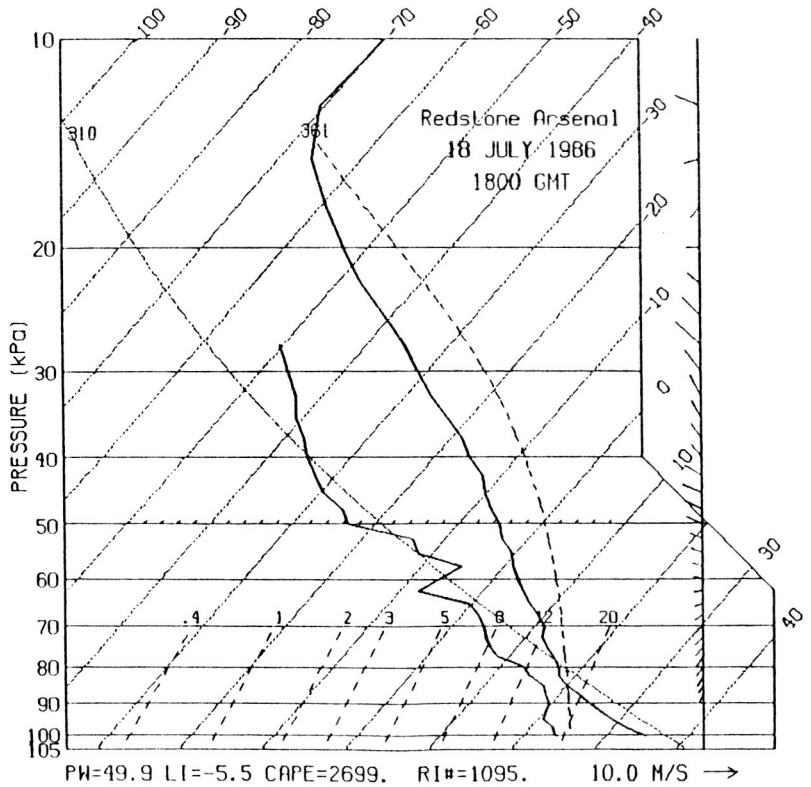


Fig. 3.2-47c. Redstone Arsenal, AL, rawinsonde sounding for 18 July 1986 1800 GMT

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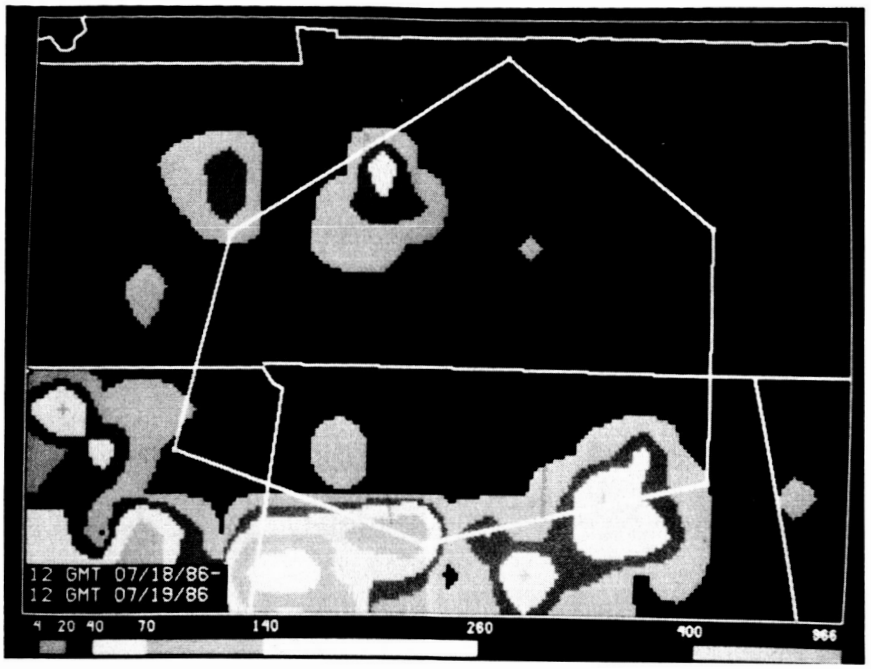


Fig. 3.2-47d. Twenty-four hour lightning strike density plot for 18-19 July 1986

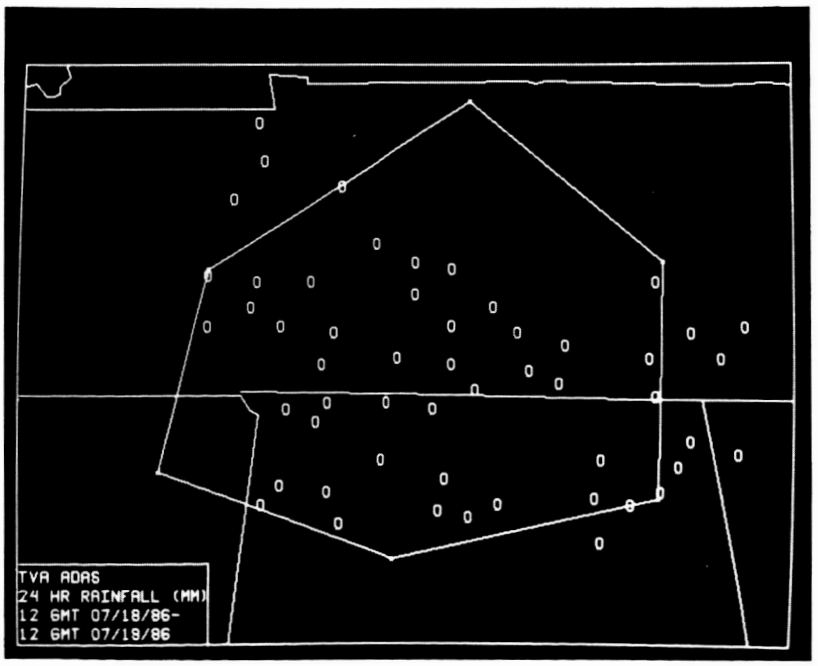


Fig. 3.2-47e. Twenty-four hour TVA ADAS rainfall totals (mm) for 18-19 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

19 July 1986

Synoptic Conditions

The deep anticyclone remained over the Southeast region, having moved slightly southward over central Tennessee by 1200 GMT today. Both the area and intensity of this anticyclone had decreased over the past 24 h. Winds over the SPACE mesonet were extremely light (nearly calm) over most of the troposphere. Although middle level moisture content decreased since yesterday (as shown by the 1800 GMT RSA sounding and the 6.7 micrometer satellite image) high moisture values persisted from the surface up to 650 mb, and available buoyant energy remained substantial. At the surface over the SPACE mesonet, uniform conditions were again present throughout the afternoon hours. Respective typical temperature and dewpoint values were 33-34 °C and 21-22 °C in the presence of 3-5 m s^{-1} northwesterly flow.

Cloud/Precipitation Overview

Deep convection and associated precipitation were confined primarily to the central and east-central portions of the SPACE mesonet, from the MIST/FLOWS network eastward and northeastward. As on previous days, local convective clouds formed by 1630 GMT. Several cloud systems were sampled over a 6-h period, and each appeared to exhibit different structural and evolutionary characteristics. Initial precipitating cloud systems (1700 to 1900 GMT) were generally small in diameter and exhibited moderately intense reflectivity factor of ~50 dBZ. However, subsequent systems exhibited higher echo tops, greater reflectivity factor (some >65 dBZ echo cores), larger cell diameters and stronger low level outflow speeds. One intense storm observed near the HSV airport produced a microburst and maximum reflectivity factor in excess of 60 dBZ. By late afternoon, prominent low level outflows appeared to effectively initiate new clouds. The complete life cycle of one system was observed by both radar and the mobile lab late in the day. Precipitation amounts over the MIST/FLOWS network were light and isolated to the northern portion of the network. Thunderstorm activity was more widespread and apparently intense over central Alabama.

Notes

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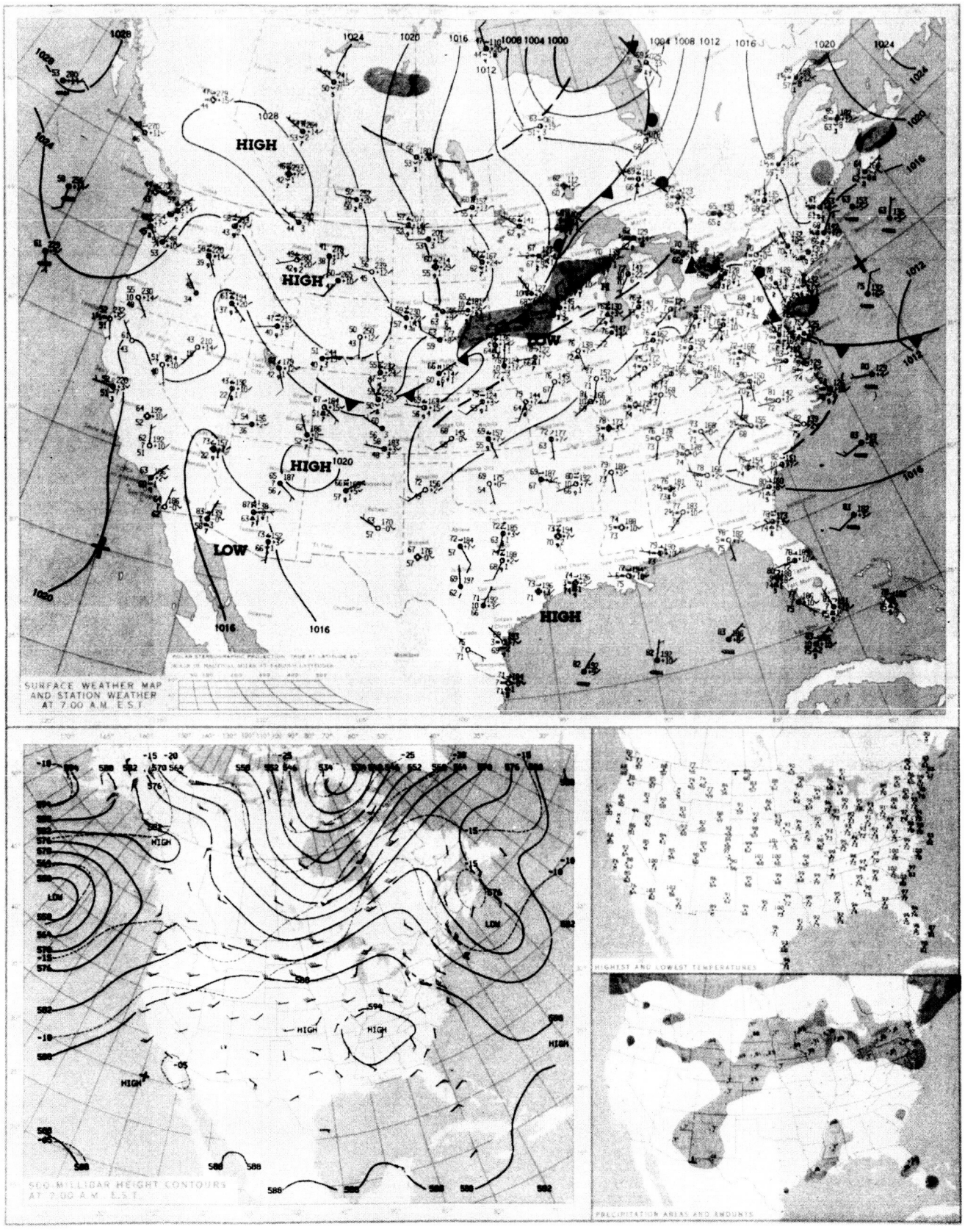


Fig. 3.2-48a. Synoptic weather conditions for 19 July 1986 1200 GMT

OPERATIONAL SUMMARY

19 July 1986

Rawinsonde Operations

The 1200 and 1800 GMT RSA launches represent the only special soundings taken. The 1800 GMT sounding should provide a representative cloud environment.

Radar Operations

The Doppler radars were active over a 7-h period from 1730 to 0030 GMT. Several cloud systems were sampled in a multiple Doppler mode, and many more by single Doppler. Dual Doppler scans were effected during the following time periods (a) around 1800 GMT on targets east of the radars, (b) from 1840 to 1910 GMT on targets to the northwest, (c) from 1920 to 1935 GMT on the southeast lobe, (d) from 1936 to 1950 GMT over the northwest lobe, (e) from 1950 to 2130 GMT on selected echoes to the northeast and southeast, and (f) from 2240 to 2340 GMT on clouds that were developing along an outflow boundary over the northwest lobe. Data quality should be good. FL-2 personnel noted three microbursts and one gust front from nearby thunderstorms.

Satellite Operations

Normal frequency observations were made by GOES. VAS products were acquired through 2130 GMT.

Aircraft Operations

The Citation, the only operational aircraft, sampled several cloud systems. Flight patterns consisted of both cloud penetrations and boxes at different levels around clouds.

Notes

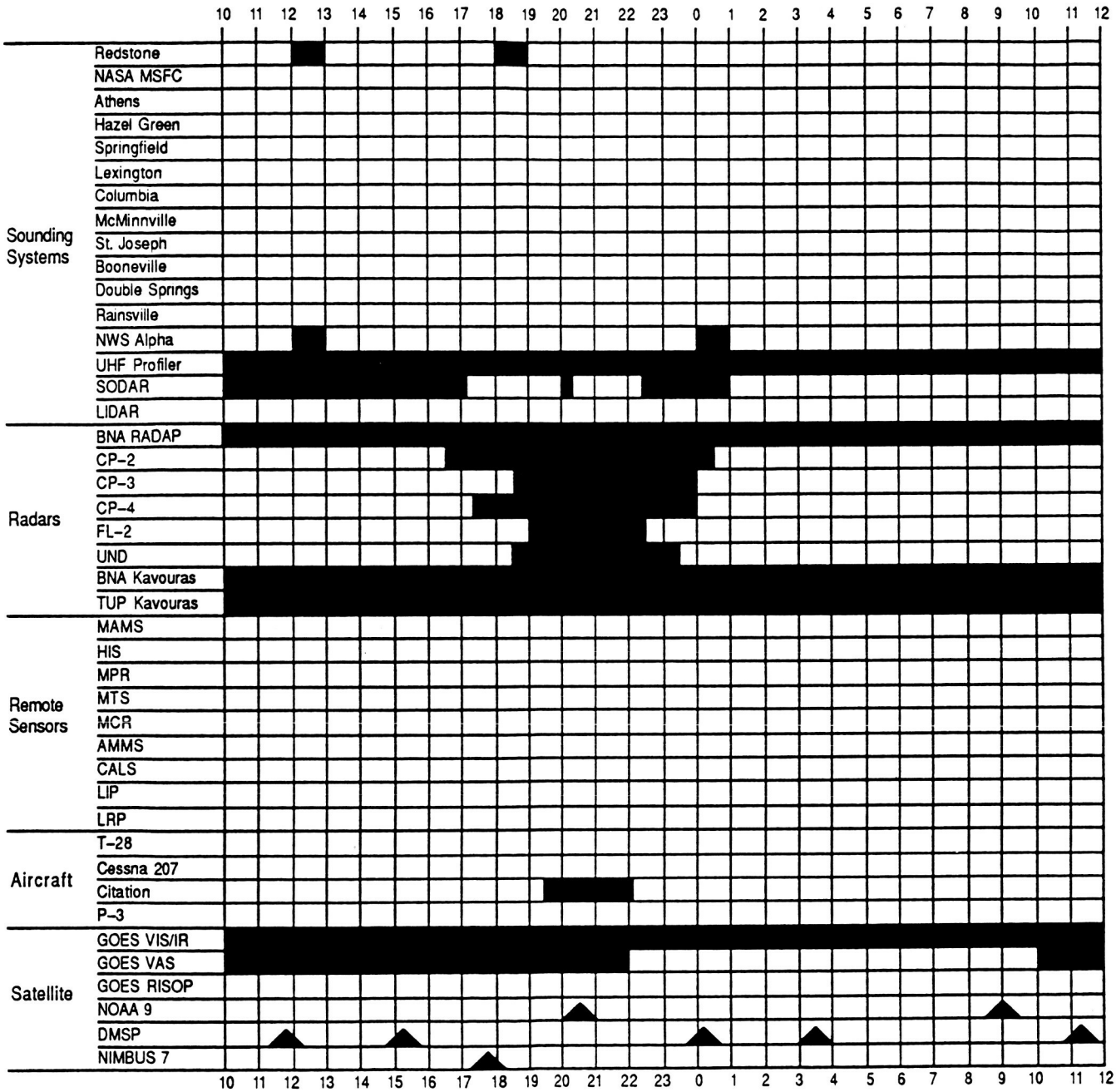
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5-550-7-8(48)

Day: SATURDAY
Date: 7/19/86
Julian Day: 200–201

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	#25 BAD T/W
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 21, 42, 56 & 59
	LLP	OPERATIONAL
	Mobile Lab	1845–0000 GMT; BALLOON LAUNCHES



Fig. 3.2-48b. Visible 2 km GOES Central satellite image for 19 July 1986 2101 GMT

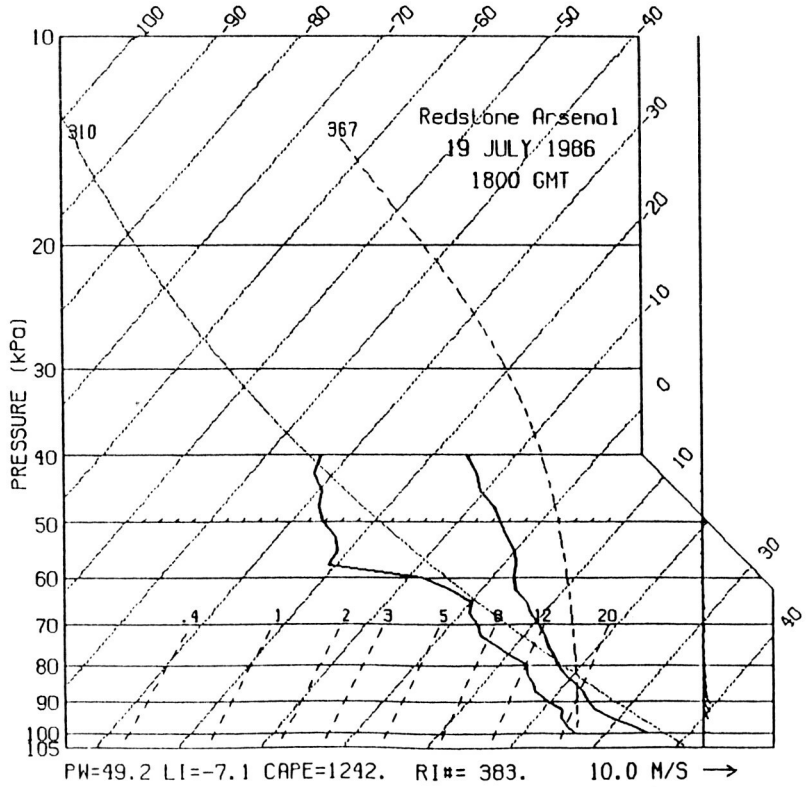


Fig. 3.2-48c. Redstone Arsenal, AL, rawinsonde sounding for 19 July 1986 1800 GMT

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Fig. 3.2-48d. Twenty-four hour lightning strike density plot for 19-20 July 1986



Fig. 3.2-48e. Twenty-four hour TVA ADAS rainfall totals (mm) for 19-20 July 1986

SYNOPTIC AND OPERATIONAL OVERVIEW

20 July 1986

Synoptic Conditions

The subtropical ridge continued to weaken and broaden while drifting southward over the past 24 h. As a consequence, weak westerly flow of ~5 m s^{-1} appeared over the SPACE mesonet. At the surface a cold core low level anticyclone pushed a weak cold front into the northern SPACE mesonet during the afternoon hours. Variations across the front were small. Available buoyant energy of the atmosphere over the SPACE region remained high. Surface temperatures over the SPACE mesonet were hot at 35-37 °C, and dewpoints varied from 17-20 °C.

Cloud/Precipitation Overview

Widely scattered thunderstorm activity occurred over two regions of the SPACE mesonet during the afternoon hours. Initial convection developed just east of the MIST/FLOWS network around 1900 GMT. The first cloud in this system appeared to be initiated by a low level convergent zone which appeared in the Doppler displays more than 30-min prior to development of intense echo. The cloud grew explosively, developed reflectivity to near 70 dBZ aloft, produced strong outflow as the precipitation descended to low levels, and then dissipated, all over a 30-40 min period. Pea sized hail was reported at the surface. A second multicellular cloud system subsequently developed near 2000 GMT to the southeast of the first and existed for about 90-min.

A broken line of intense but small convective cells formed over the north-central beta network after 2000 GMT and persisted through 2300 GMT. Some cells within the line achieved reflectivities greater than 65 dBZ despite generally small cell sizes and short cell life times. Precipitation accumulations over the beta network were isolated.

Notes

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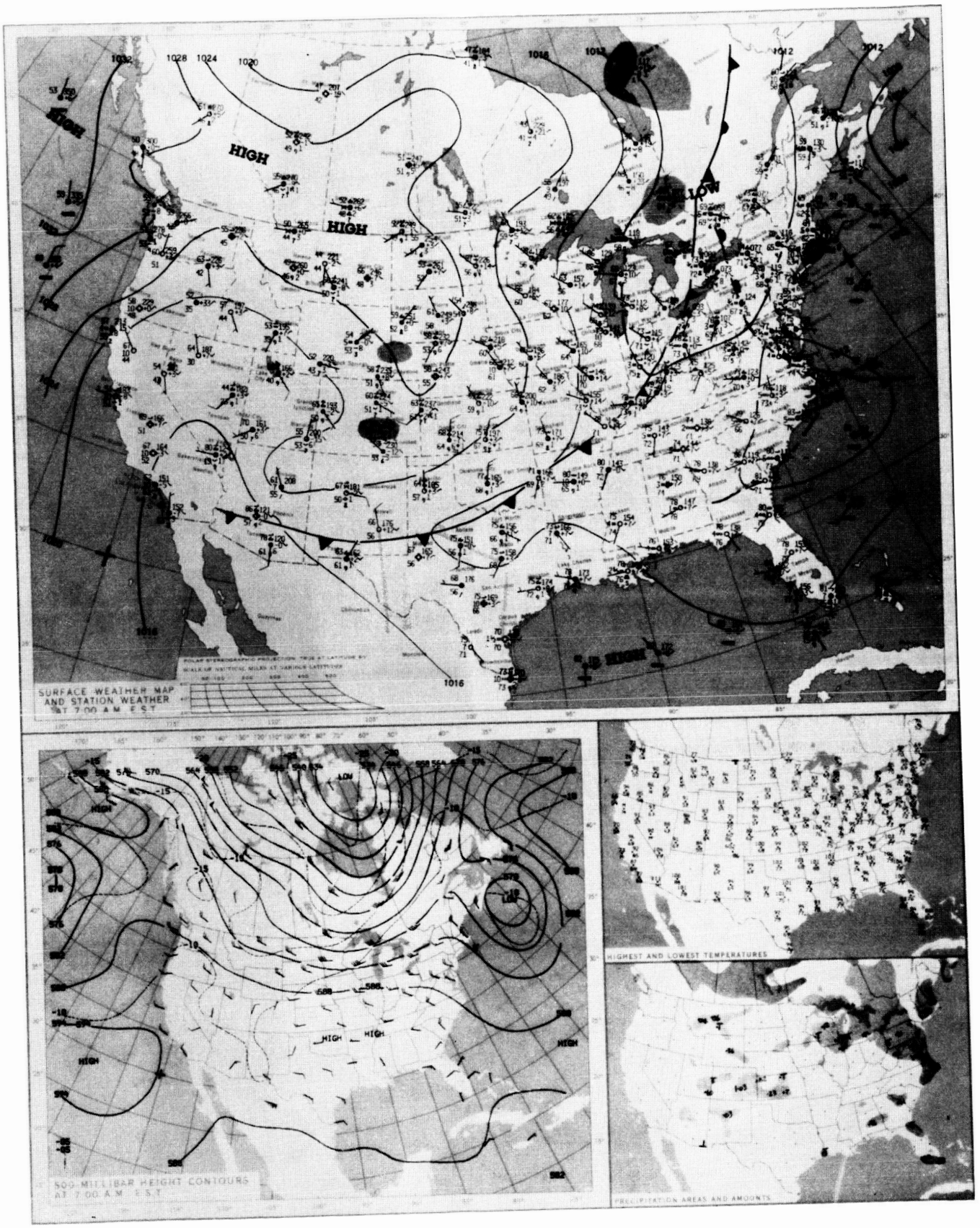


Fig. 3.2-49a. Synoptic weather conditions for 20 July 1986 1200 GMT

OPERATIONAL SUMMARY

20 July 1986

Rawinsonde Operations

A complete Meso-beta operation was conducted at 3-h intervals from 1800 to 0300 GMT. Missing soundings include all those at St. Joseph and one (2100 GMT) at Hazel Green.

Radar Operations

Two sequences of multiple Doppler operations were conducted. The first was from 1842 to 1945 GMT and recorded the developing to dissipating stages of an intense, isolated cumulonimbus cloud. A pre-existing PBL convergence zone was examined closely for about 30-min prior to explosive cloud growth. The second period, from 2000 to 2050 GMT, examined a multicellular system in the far southeastern lobe. After 2100 GMT, surveillance, PPI and RHI scans examined the convection over the central and northern beta network. FL-2 missed the initial microburst producing storm just east of the MIST/FLOWS network, but detected three microbursts out of convection located 25-30 km to the east and southeast.

Satellite Operations

The GOES platform collected VAS products up to 1830 GMT, after which RISOP was initiated. This mixture should provide a good data set on the cloud initiation and subsequent cloud growth processes that were measured by Doppler radar.

Aircraft Operations

Four aircraft were operational. The Citation sampled the second cloud system, described above, located 30 km southeast of the MIST/FLOWS network. Several box patterns and penetrations were completed.

The P-3 sampled both the first and second cloud systems near the MIST/FLOWS network, making one circuit around the first. Fly-by patterns were flown on the second system also being probed by the Citation. The P-3 then flew 150 km north to a broken line of intense convective echoes over the northern beta network, but desired flight patterns were interrupted by BNA air traffic control.

The U-2 and T-28 also worked the northern cloud line, each sampling several clouds. The T-28 accomplished 8 penetrations through clouds (~12,000 ft) primarily in their dissipating stages. At least one penetration was coordinated with a U-2 overflight.

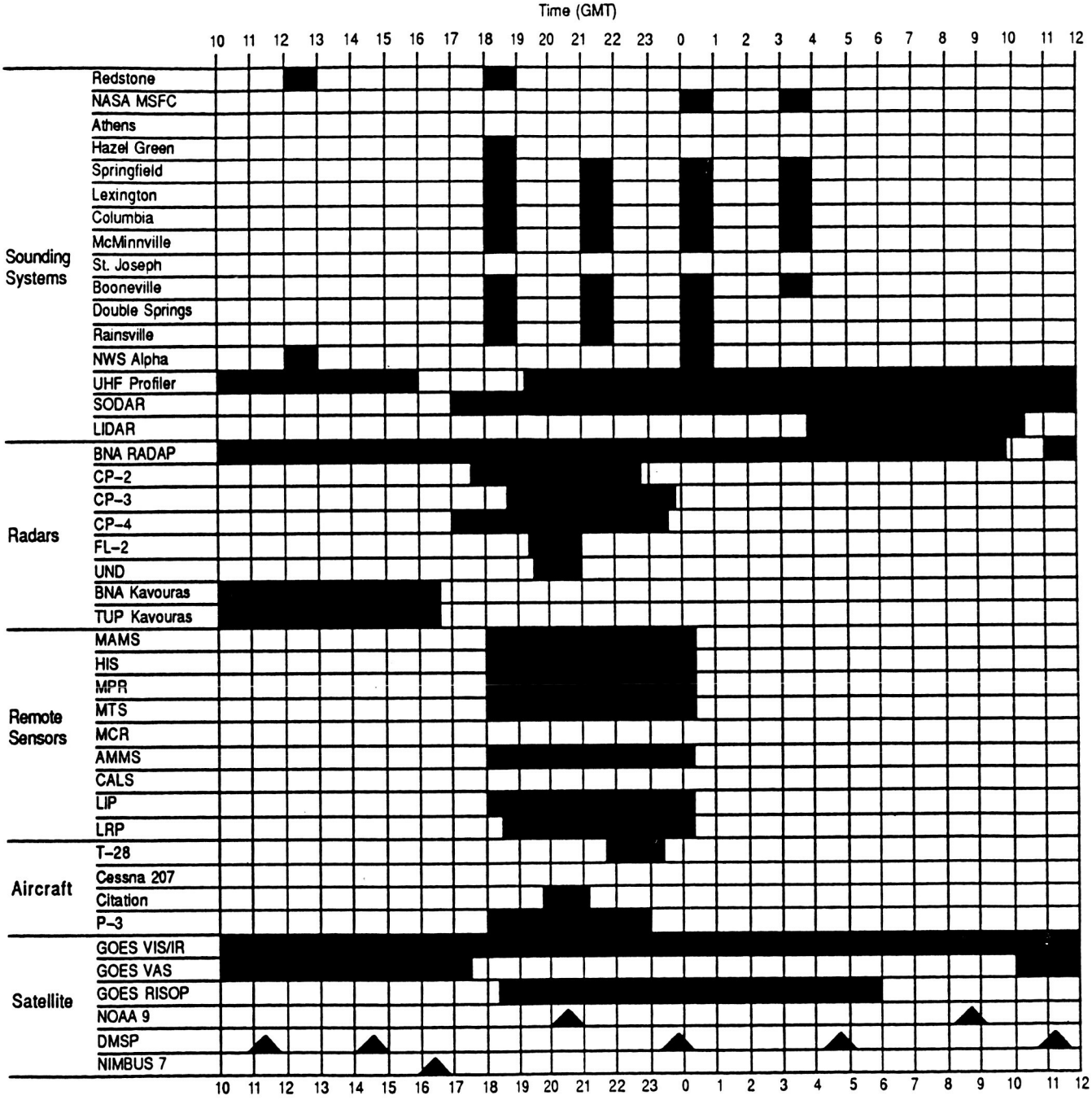
Notes

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5-550-7-8 (49)

Day: SUNDAY
Date: 7/20/86
Julian Day: 201–202

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	#25, T/TW BAD
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 21, 30, 42, 56, & 59
	LLP	OPERATIONAL
	Mobile Lab	1900–2300 GMT; BALLOON LAUNCH

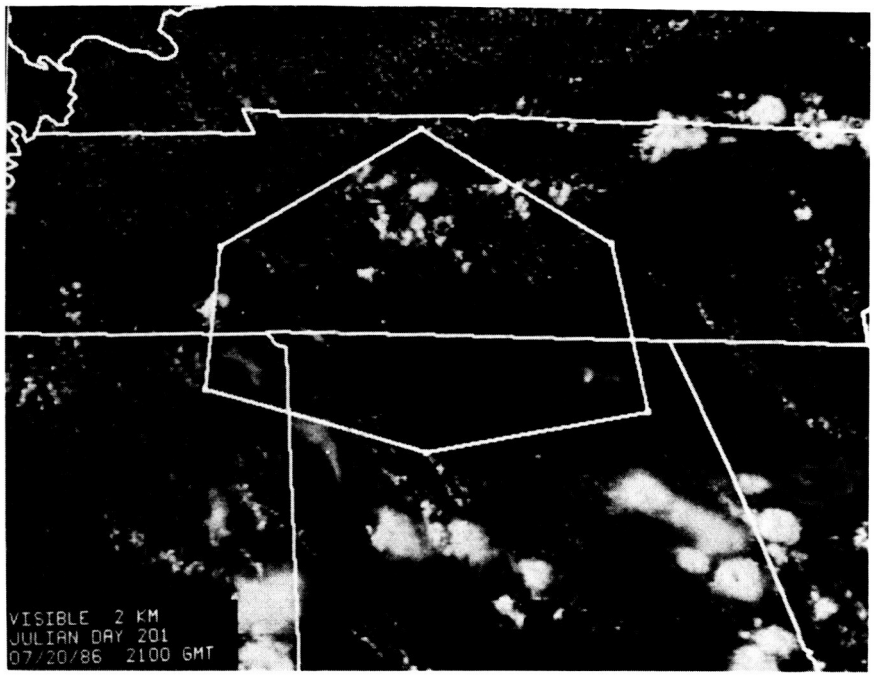


Fig. 3.2-49b. Visible 2 km GOES Central satellite image for 20 July 1986 2100 GMT

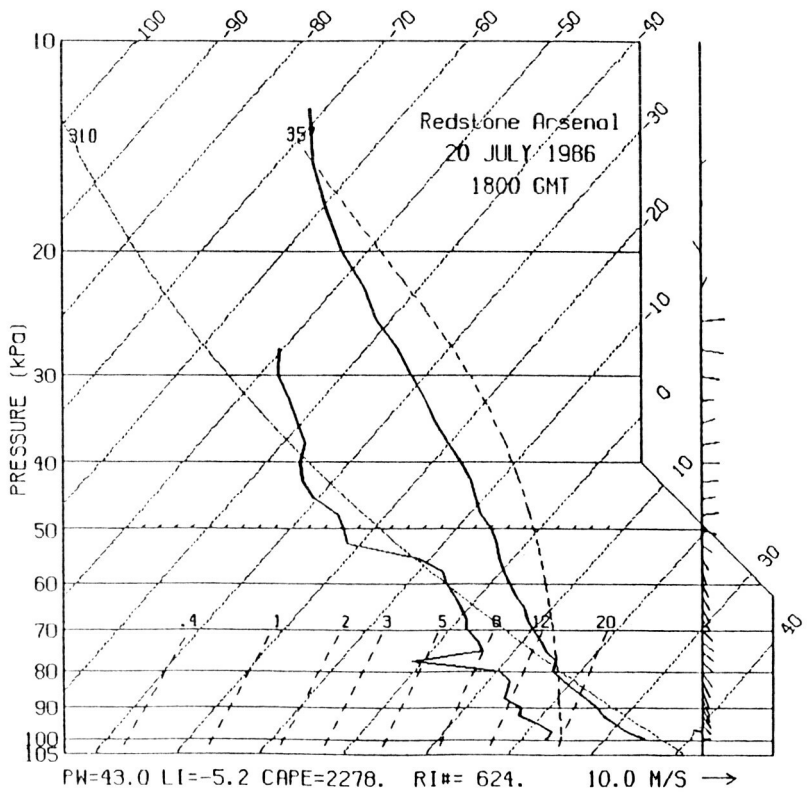


Fig. 3.2-49c. Redstone Arsenal, AL, rawinsonde sounding for 20 July 1986 1800 GMT

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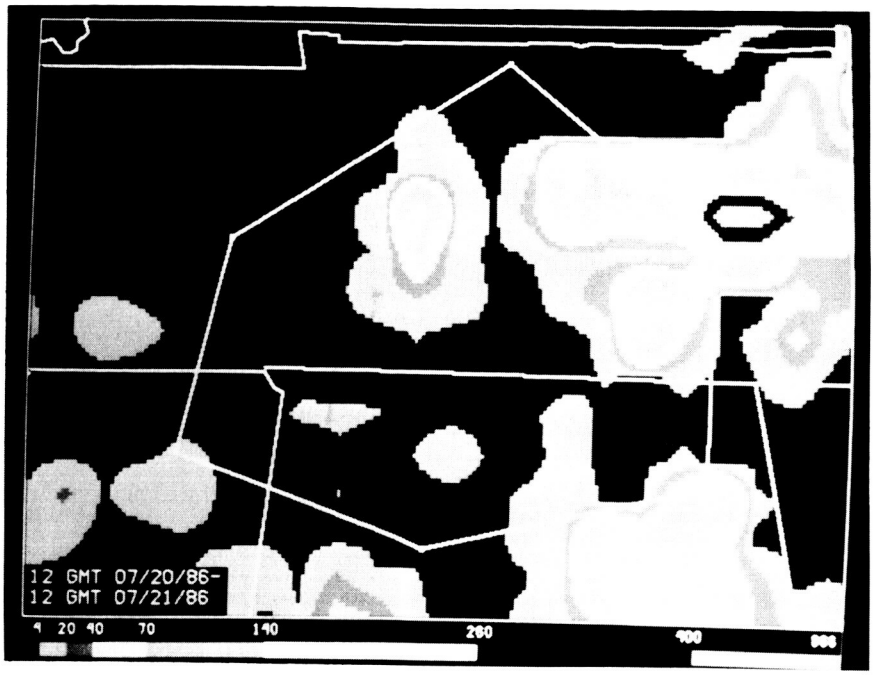


Fig. 3.2-49d. Twenty-four hour lightning strike density plot for 20-21 July 1986

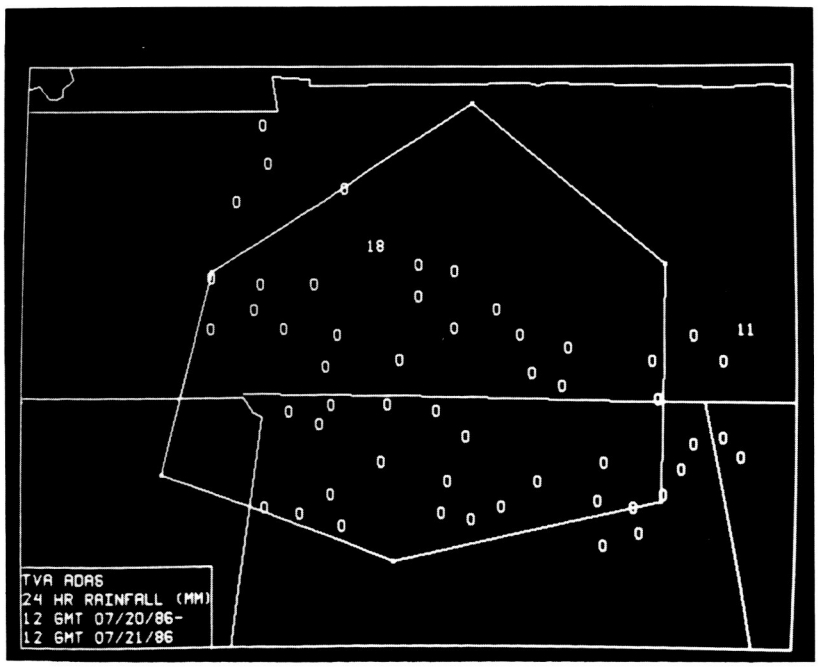


Fig. 3.2-49e. Twenty-four hour TVA ADAS rainfall totals (mm) for 20-21 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

21 July 1986

Synoptic Conditions

The location of the warm core ridge remained ~ 300 km south of the SPACE mesonet. Upper level flow was somewhat stronger westerly than yesterday, but vertical wind shear stayed very low in magnitude. The cold front that moved over the network over the previous 24 h was essentially a slight wind shift. Low level moisture showed no significant change over the region from yesterday. The 6.7 micrometer water vapor image displayed a uniform distribution of moderate midlevel moisture over the region. Although convective available potential energy of the environment increased over yesterday's value, the stable layer visible within the 850-800 mb layer was apparently strong enough to inhibit deep convection over the SPACE network. At the surface, afternoon temperature and dewpoint values over the SPACE mesonet were 31-34 °C and 18-21 °C, respectively. Surface flow was light (2-4 m s^{-1}) from a northeasterly to northwesterly direction.

Cloud/Precipitation Overview

The more stable air at low levels behind the cold front prevented generation of deep convection over the SPACE mesonet. Only the southern border of the network near the frontal zone experienced deep convection during the afternoon. Skies over the beta region were generally clear. Only cumulus humilis arranged in north to south streets were apparent over the central beta network (see the visible satellite photo). However, thunderstorm activity in central Alabama and Mississippi was intense. Wind damage was reported in Birmingham, Montgomery and Ozark.

Notes:

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21 July 1986

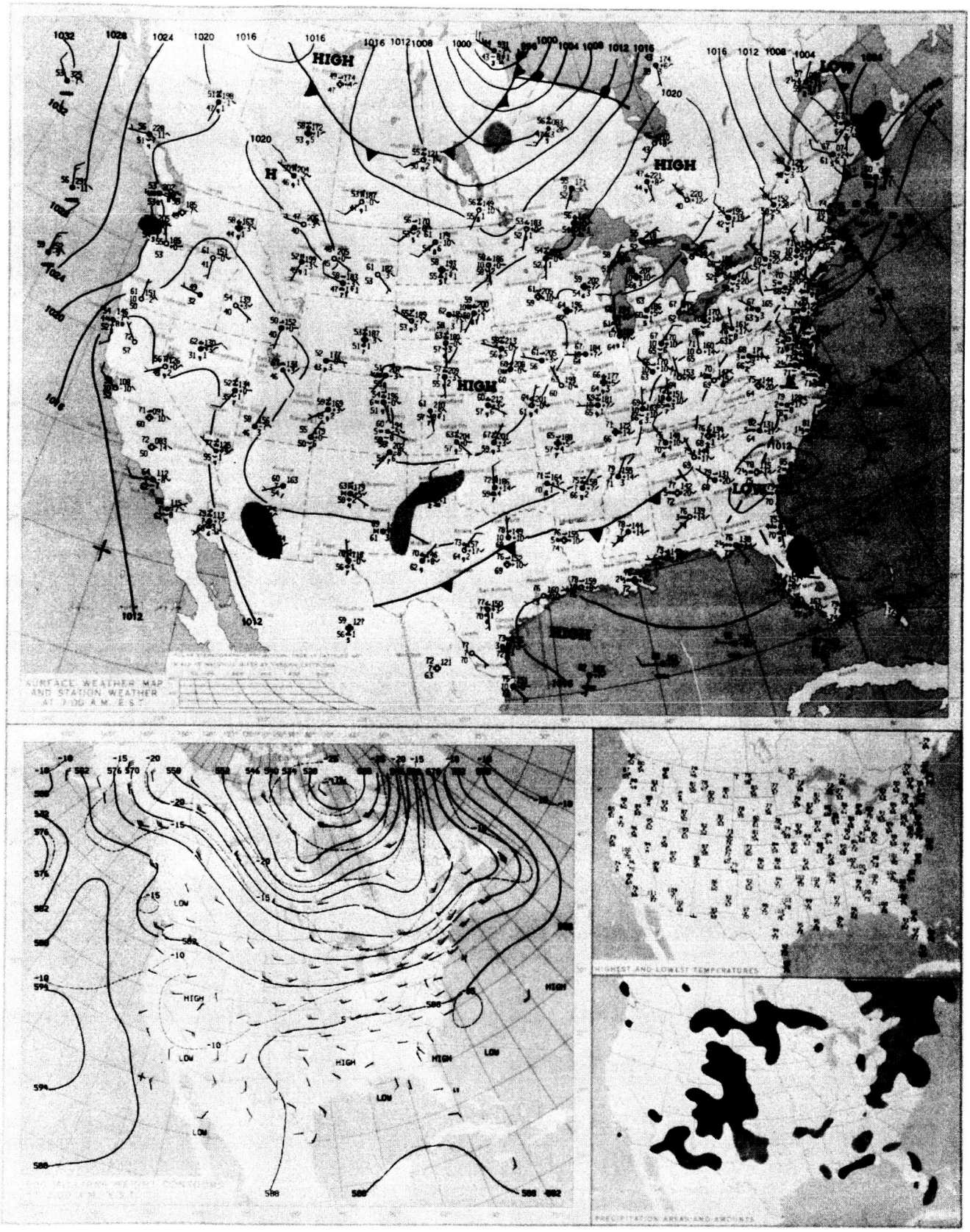


Fig. 3.2-50a. Synoptic weather conditions for 21 July 1986 1200 GMT

OPERATIONAL SUMMARY

21 July 1986

Rawinsonde Operations

A full Meso-beta rawinsonde operation was effected from 1500 to 2100 GMT at 3-h intervals. The Columbia station was not functional. Only the southeastern most station soundings would typify the environment of the intense activity over central Alabama. Otherwise, the only useful information is probably related to post-frontal structure.

Radar Operations

Miscellaneous scans were implemented by CP-2 and CP-4 to examine that area of convection 100 km and more south of the Doppler network. Due to the long ranges involved, these data will have limited use in any quantitative analysis.

Satellite Operations

GOES VAS satellite products were archived through 1830 GMT, after which RISOP was started.

Aircraft Operations

The U-2 flew two legs on a sounding flight over the SPACE mesonet, then encountered instrument problems and returned after about 30-min research time. The P-3 sampled some intense storms near the Birmingham area from 1800 to 2020 GMT. This mission was terminated early because of air traffic control conflicts. Finally, the Cessna 207 flew a radial to and from 220° at 150 km from HSV. No interesting phenomenon were encountered within the boundary layer, and operations were therefore ended.

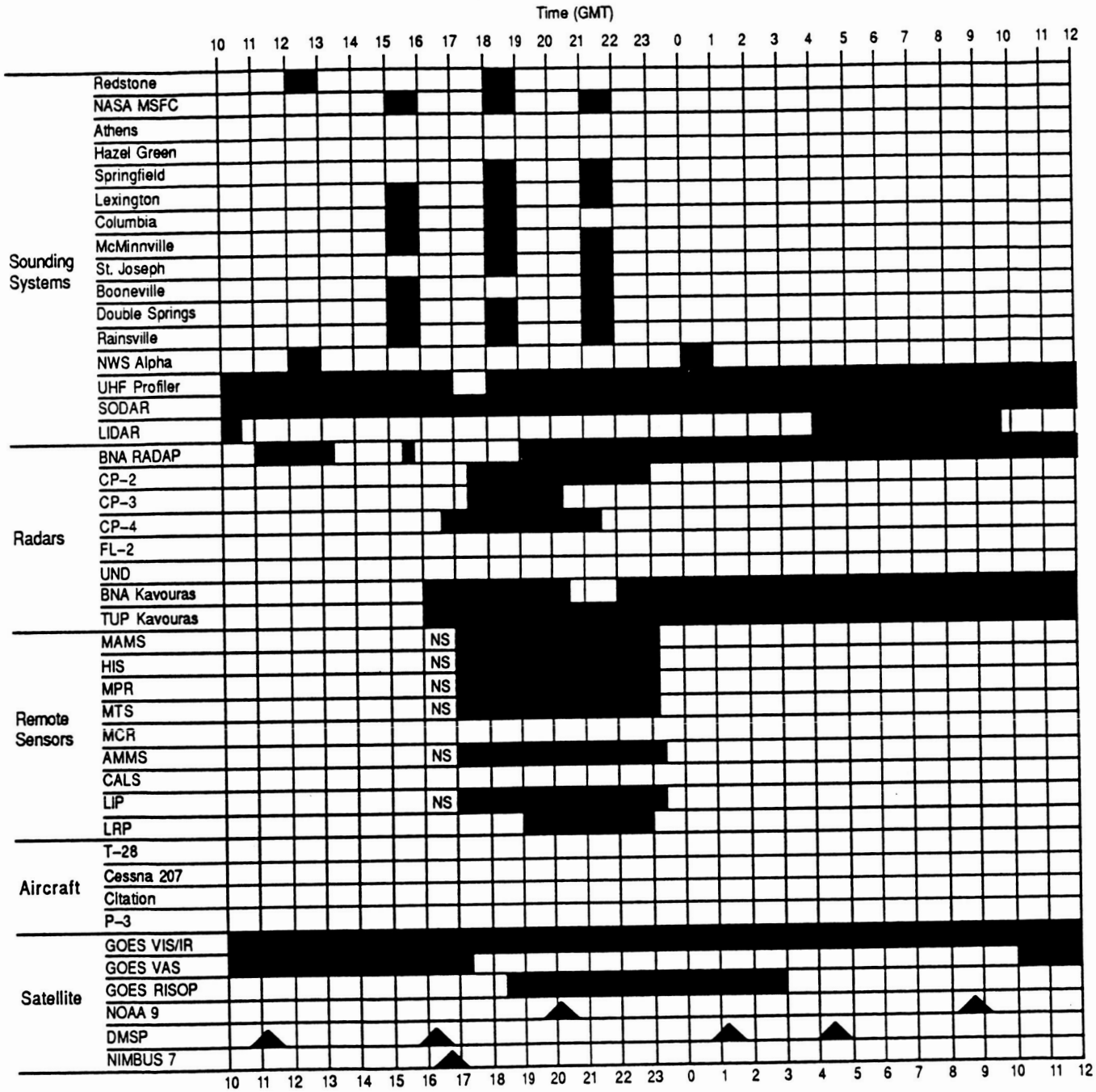
Notes:

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5-550-7-8(50)

Day: MONDAY
Date: 7/21/86
Julian Day: 202–203

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 21, 42, 52, 59 & 62
	LLP	OPERATIONAL
	Mobile Lab	2030–2230 GMT

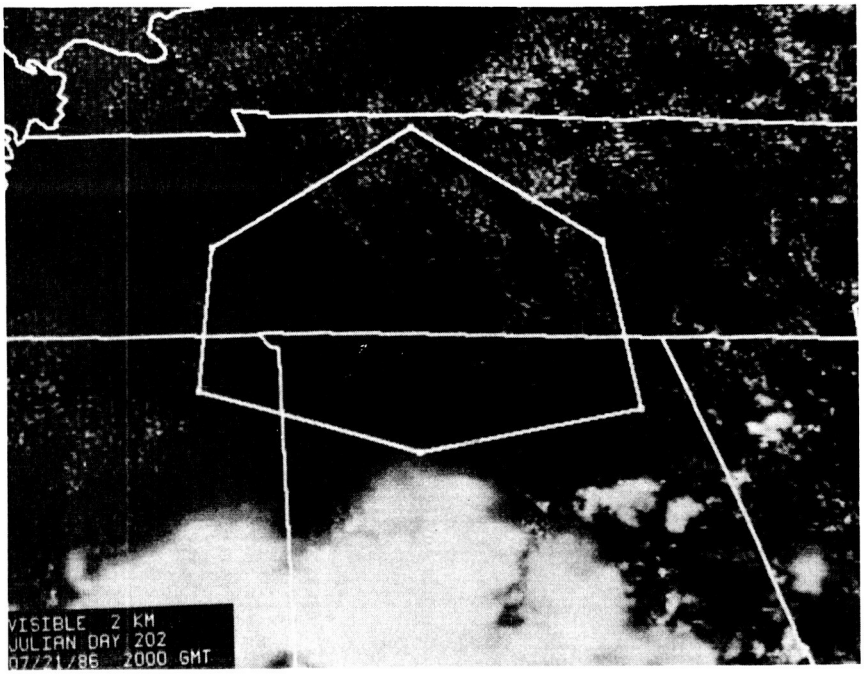


Fig. 3.2-50b. Visible 2 km GOES Central satellite image for 21 July 1986 2000 GMT

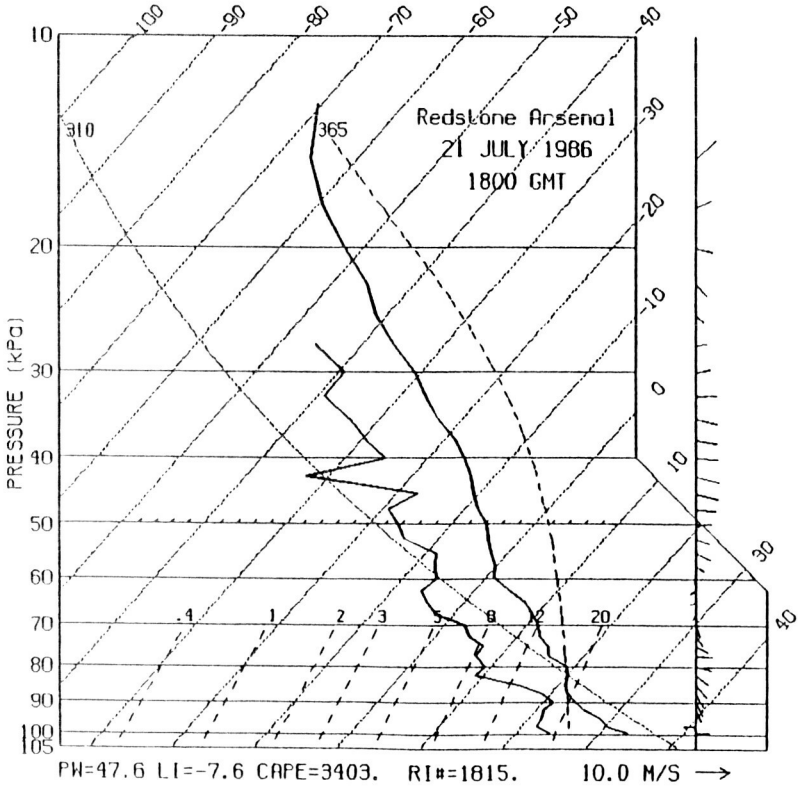


Fig. 3.2-50c. Redstone Arsenal, AL, rawinsonde sounding for 21 July 1986 1800 GMT

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Fig. 3.2-50d. Twenty-four hour lightning strike density plot for 21-22 July 1986

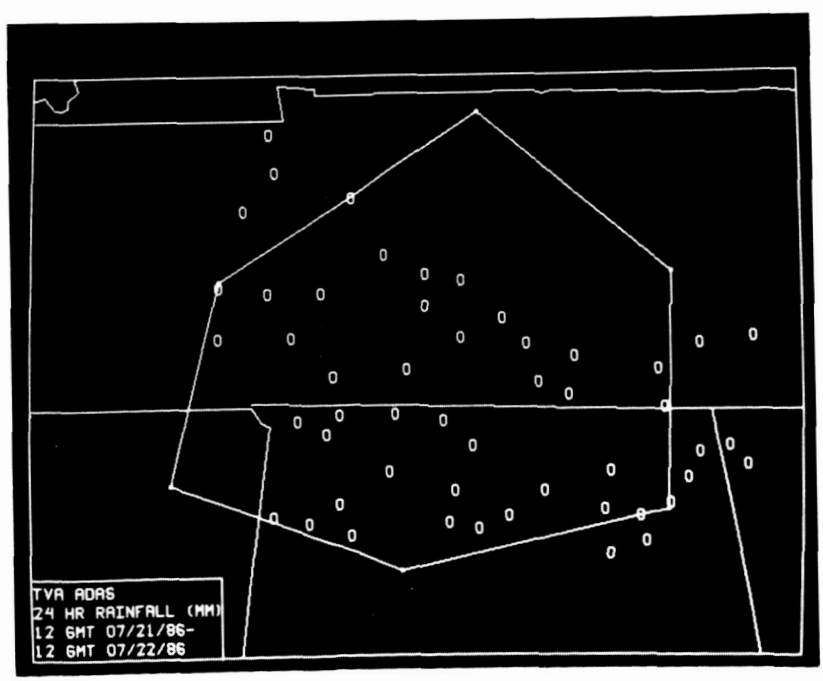


Fig. 3.2-50e. Twenty-four hour TVA ADAS rainfall totals (mm) for 21-22 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

22 July 1986

Synoptic Conditions

Moist static stability increased as temperatures increased over much of the troposphere. Although the lifted index is largely negative on the 1800 GMT RSA sounding, BNA showed a +2 LI at 1200 GMT. The broad subtropical anticyclone center showed a northerly movement to east central Tennessee. Winds over the SPACE mesonet were consequently much weaker than yesterday. A surface low pressure trough and stationary front were located south of the SPACE mesonet over central Alabama and Georgia. Winds over the SPACE region were northerly at 2-5 m s^{-1}. Surface temperature and dewpoint values ranged from 32 and 17 °C over the north, to 33 and 20 °C over the southern mesonet.

Cloud/Precipitation Overview

First cumulus clouds were observed locally near 1700 GMT. Scattered thunderstorms developed along the southern and southeastern border of the beta network, and remained there and to the south during the afternoon hours. The northern portion of the beta network remained dry and nearly cloud free.

Notes:

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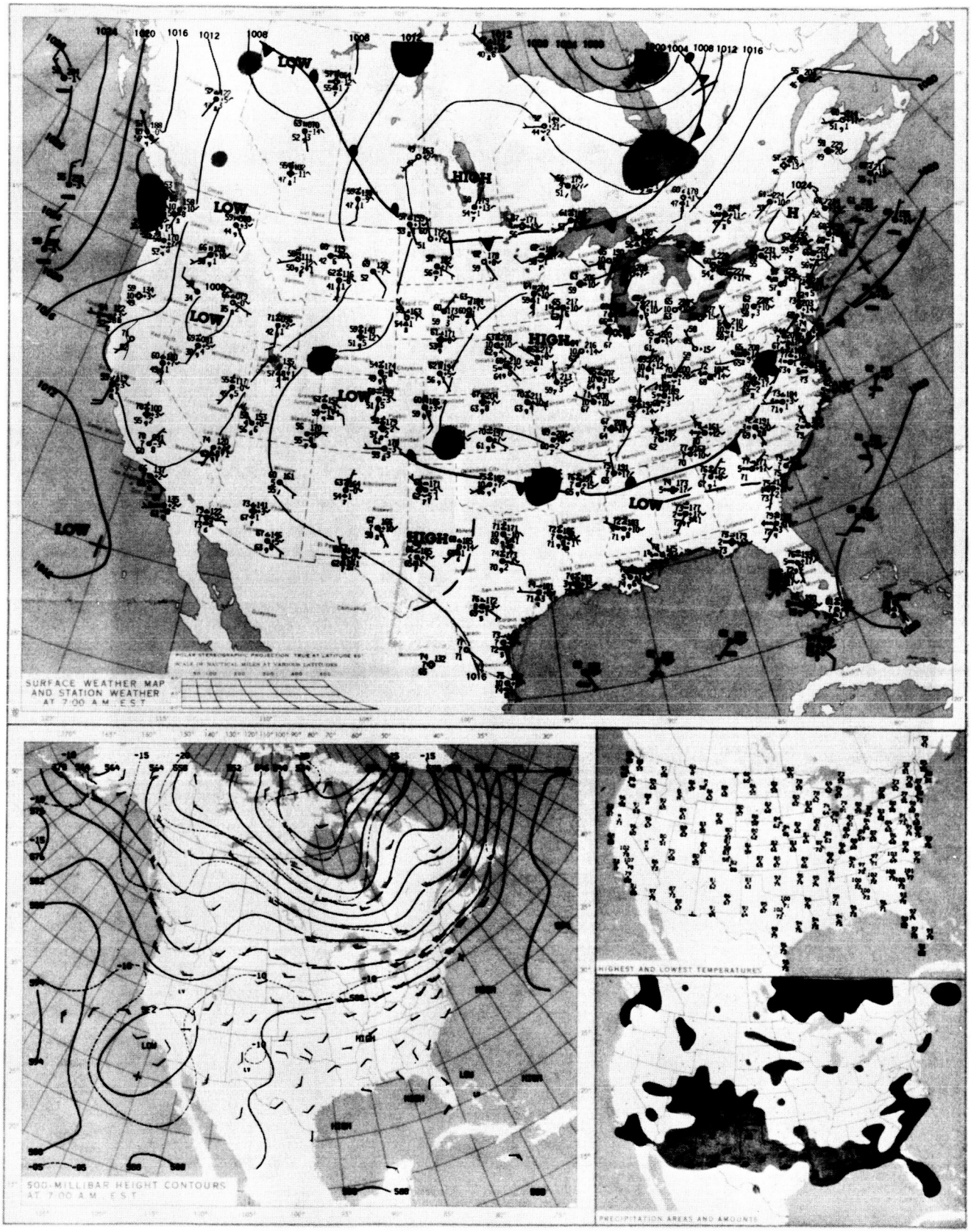


Fig. 3.2-51a. Synoptic weather conditions for 22 July 1986 1200 GMT

OPERATIONAL SUMMARY

22 July 1986

Rawinsonde Operations

A Meso-beta rawinsonde operation was conducted at 3-h intervals from 0000 to 0600 GMT.

Radar Operations

All precipitation echoes were located greater than 60 km to the south and southeast of the MIST/FLOWS network. CP-2 acquired data in varying scan modes on these echoes. Echo intensities and tops were generally lower than in cells observed yesterday. FL-2 observed a fine line (gust front) associated with convection located 60 km south.

Satellite Operations

Normal operations were conducted. VAS products were archived through 2130 GMT.

Aircraft Operations

The P-3 flew to the southwest well outside the SPACE region and acquired data on a weak cyclonic circulation and associated scattered thunderstorm activity over central Mississippi. The T-28 worked clouds 80 km south of HSV, making 8 cloud penetrations between 2030 and 2130 GMT. The Citation and Cessna 207 also conducted research missions in this region along the south border the SPACE network. The Citation accomplished both box patterns around clouds and penetrations into clouds, including one cloud being probed by the T-28. The 207 acquired measurement at low levels throughout.

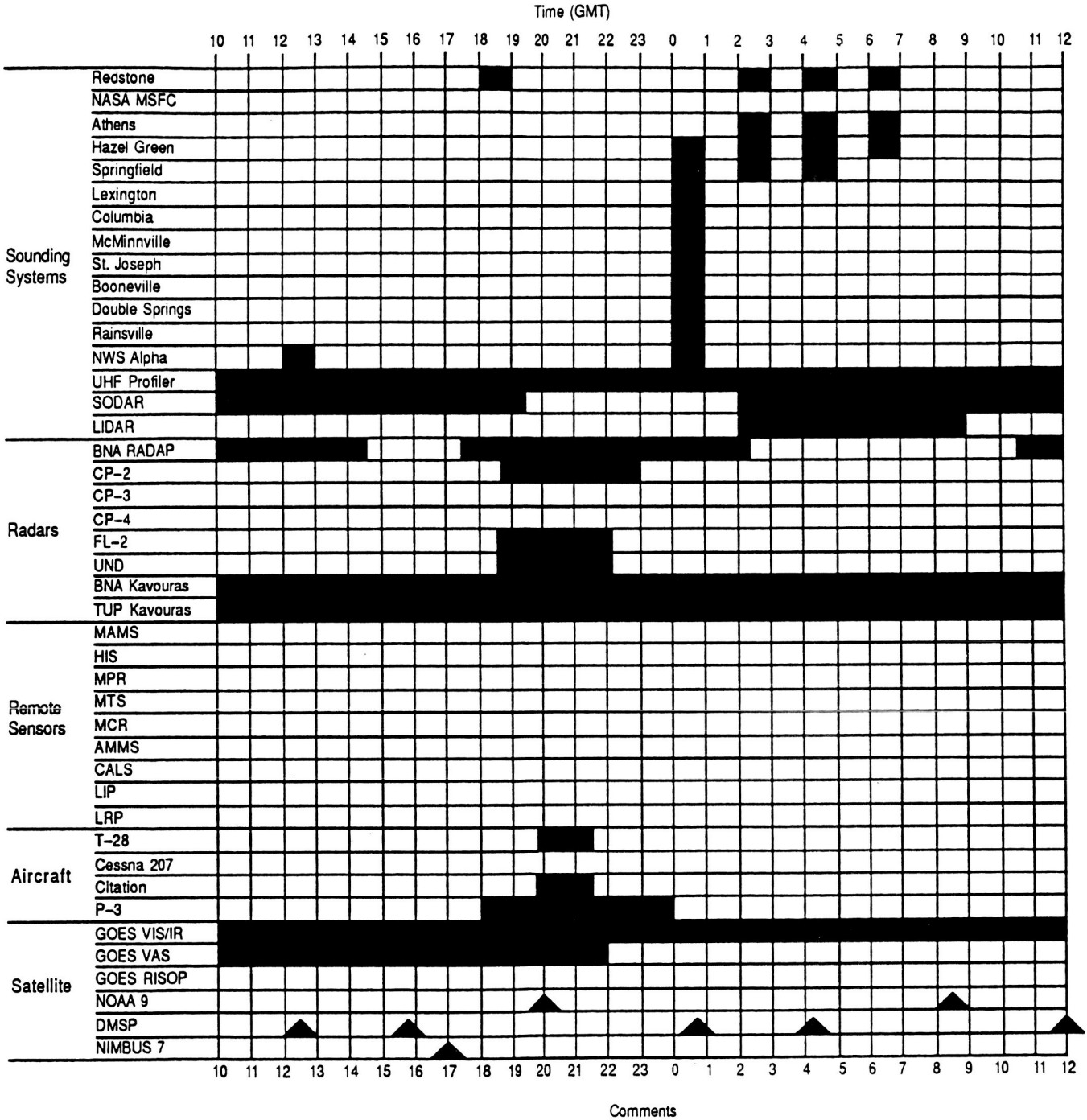
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5-550-7-8 (51)

Day: TUESDAY
Date: 7/22/86
Julian Day: 203-204

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 3 & 5
	TVA ADAS	MISSING STATIONS 21, 42, 45, 52, 56, 59, & 62
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

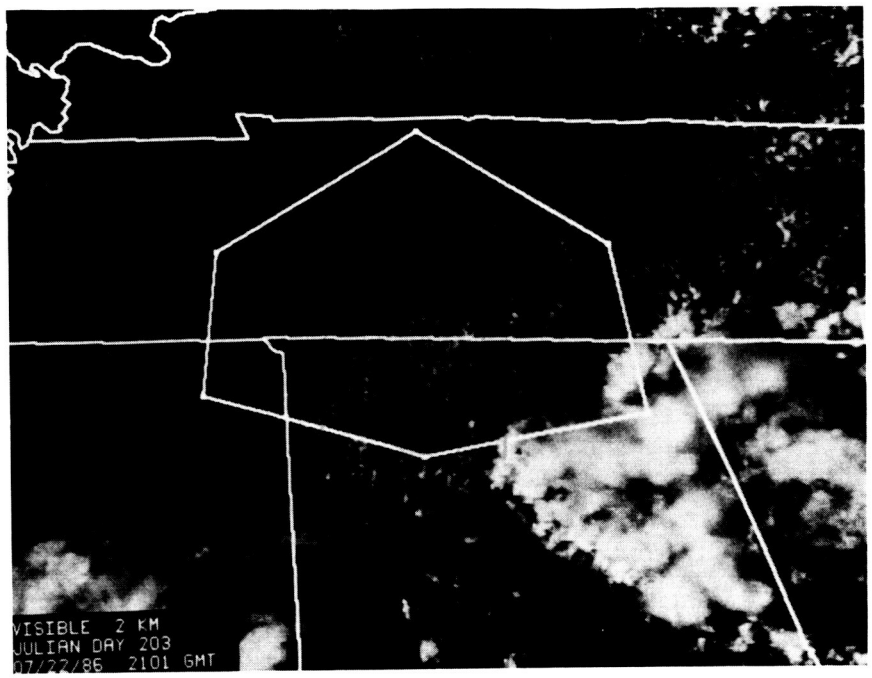


Fig. 3.2-51b. Visible 2 km GOES Central satellite image for 22 July 1986 2101 GMT

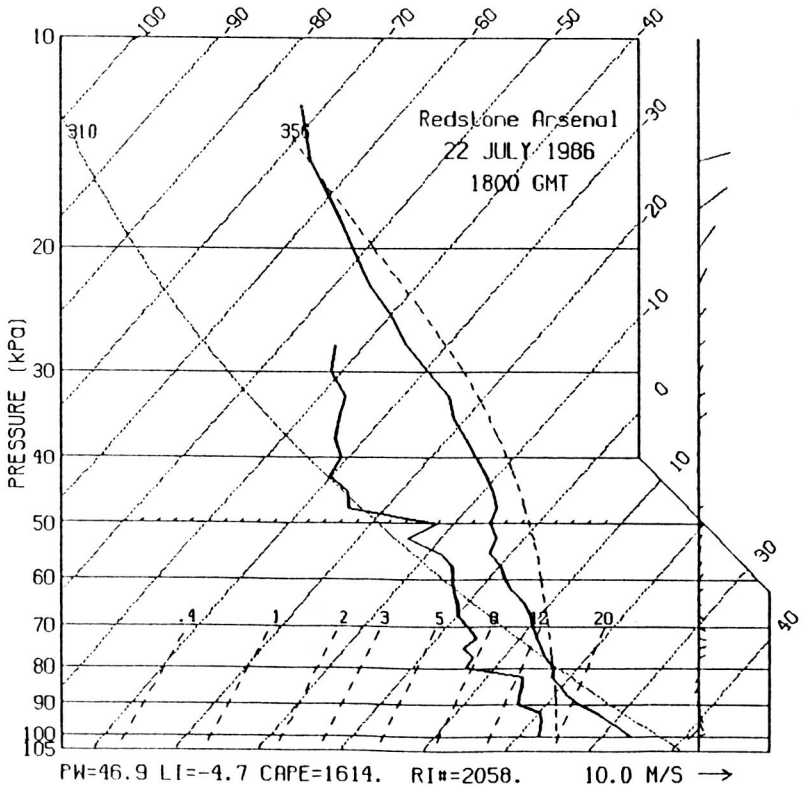


Fig. 3.2-51c. Redstone Arsenal, AL, rawinsonde sounding for 22 July 1986 1800 GMT

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Fig. 3.2-51d. Twenty-four hour lightning strike density plot for 22-23 July 1986

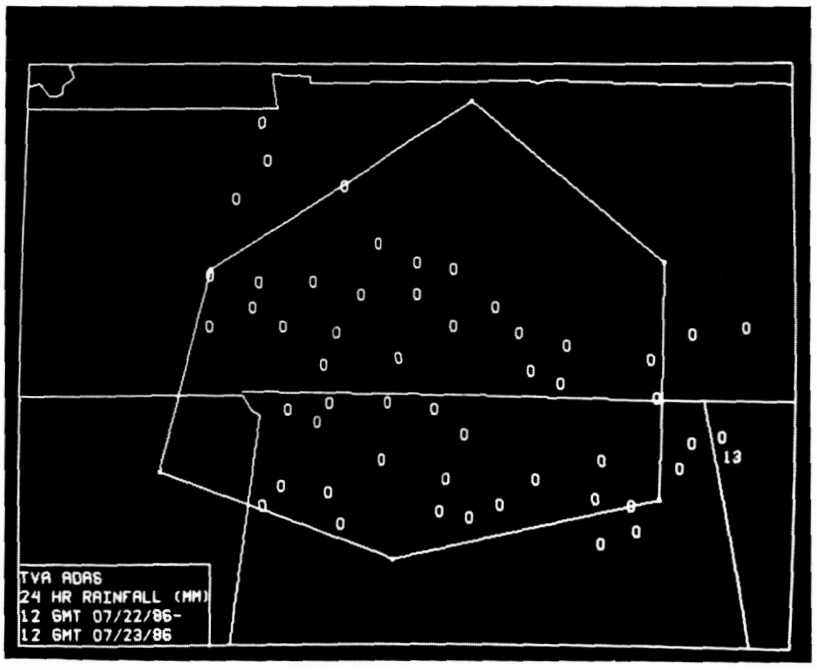


Fig. 3.2-51e. Twenty-four hour TVA ADAS rainfall totals (mm) for 22-23 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

23 July 1986

Synoptic Conditions

Very weak tropospheric flow was again prominent over the SPACE mesonet due to the stationary subtropical ridge whose axis extended from east-central Tennessee to southern Louisiana. At the surface a weak north-south pressure gradient was maintained by a diffuse low pressure region centered over south-central Alabama. Dry and relatively stable conditions therefore continued over the Southeast. Over the SPACE mesonet, afternoon temperature and dewpoint values varied from 35 and 15 °C over the northeastern corner to 34 and 19 °C over the southern mesonet.

Cloud/Precipitation Overview

Scattered precipitating convection was aligned with the surface trough and remained south and east of the SPACE network. Individual cells were of moderate intensity. Nearly clear conditions prevailed over the entire SPACE mesonet. More widespread and intense thunderstorm activity was common over southeastern Alabama and central to southern Georgia. Damaging winds and heavy rainfall were reported in Montgomery and Dothan.

Notes:

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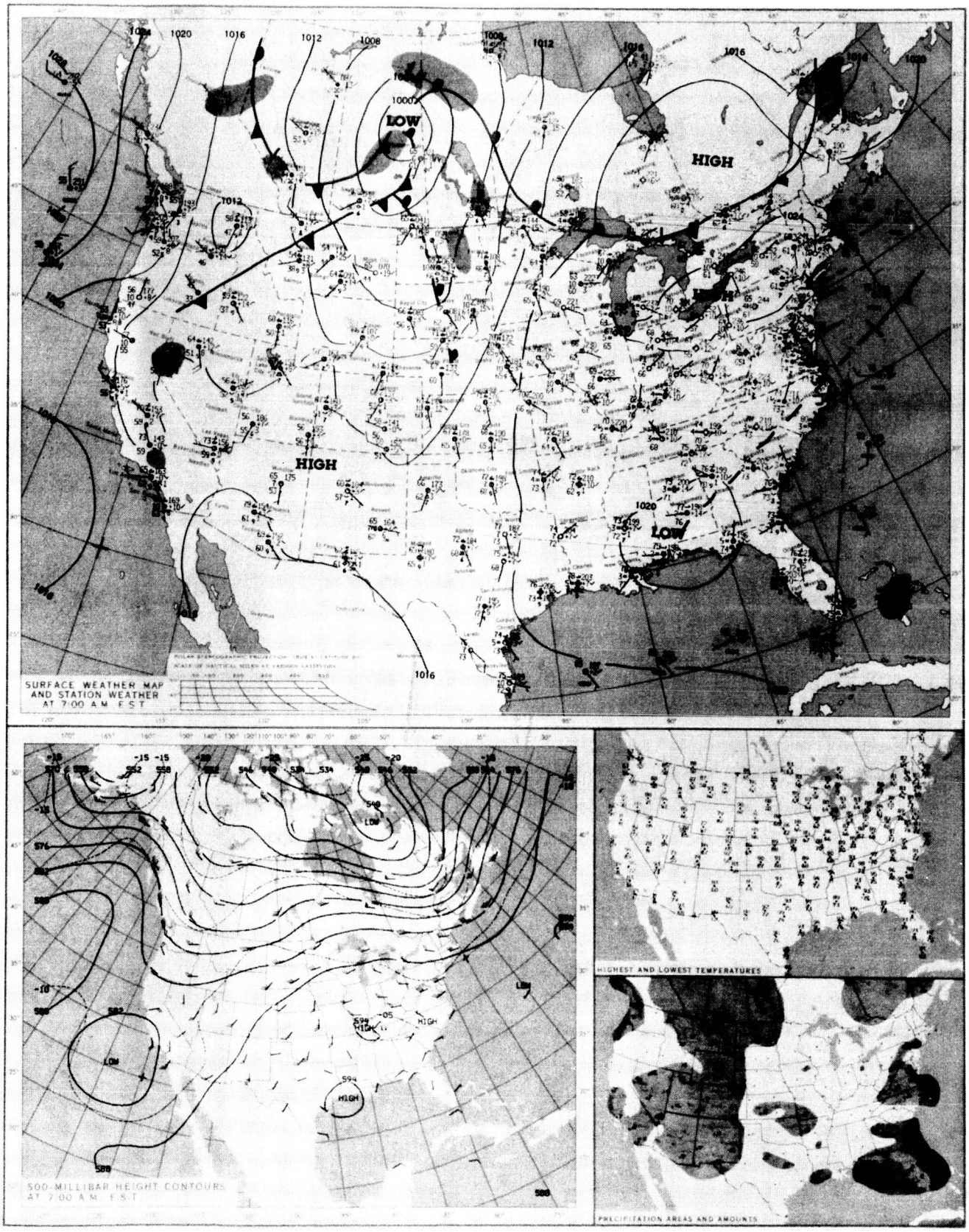


Fig. 3.2-52a. Synoptic weather conditions for 23 July 1986 1200 GMT

OPERATIONAL SUMMARY

23 July 1986

Rawinsonde Operations

Only the 1200 and 1800 GMT RSA soundings were taken.

Radar Operations

Primarily surveillance scan data were recorded by CP-2 and CP-4. Precipitation echoes were generally beyond 70 km range from CP-4 towards the southeast quadrant.

Satellite Operations

RISOP was started at 1930 GMT. VAS products were not archived today.

Aircraft Operations

The UND Citation acquired primarily low level data on a weak outflow to the south. These data should also include measurements within clear and cloudy regions.

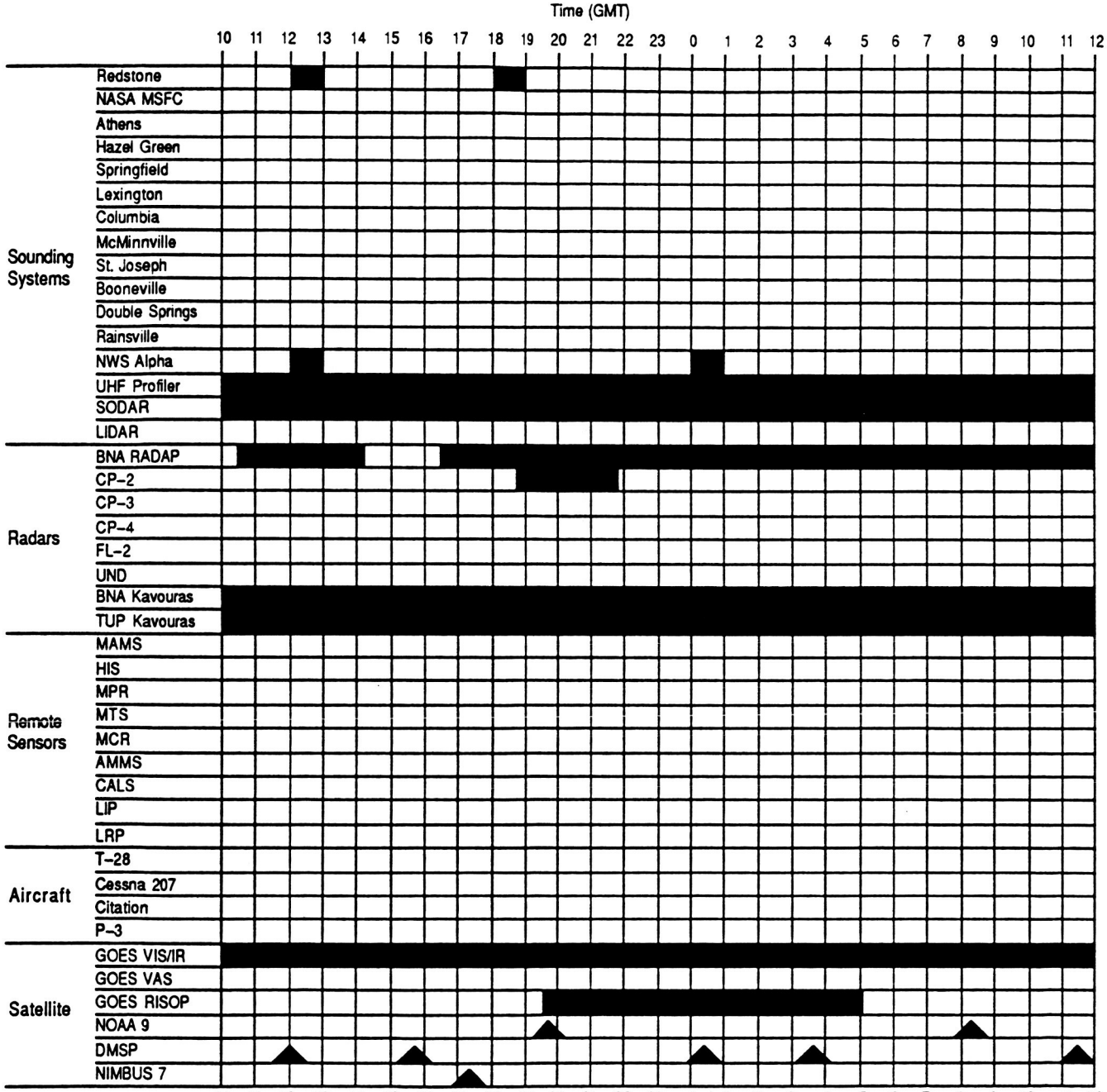
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5-550-7-8(52)

Day: WEDNESDAY
Date: 7/23/86
Julian Day: 204–205

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 3 & 5
	TVA ADAS	MISSING STATIONS 21, 42, 45, 52, 56, 59, 62 & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

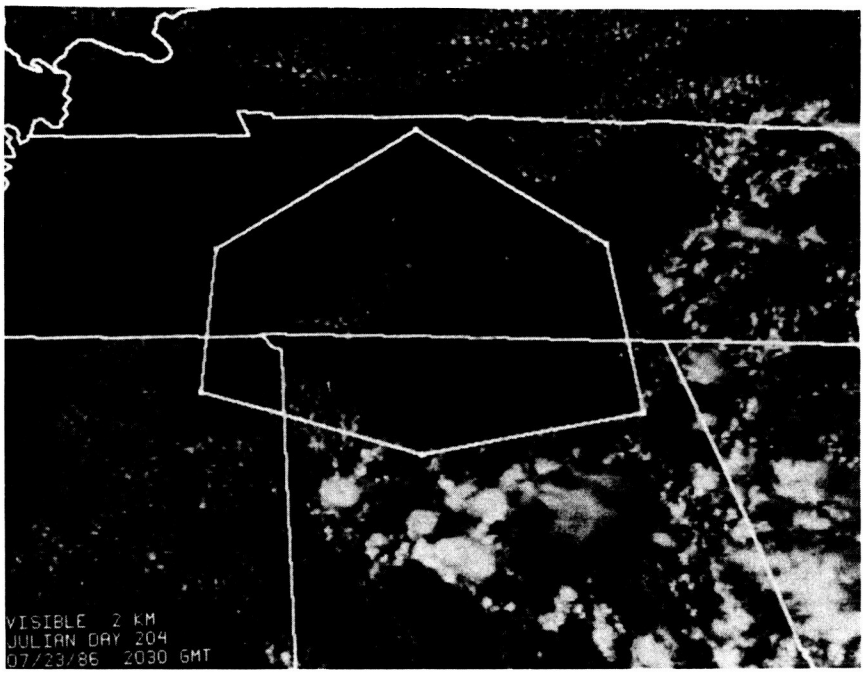


Fig. 3.2-52b. Visible 2 km GOES Central satellite image for 23 July 1986 2030 GMT

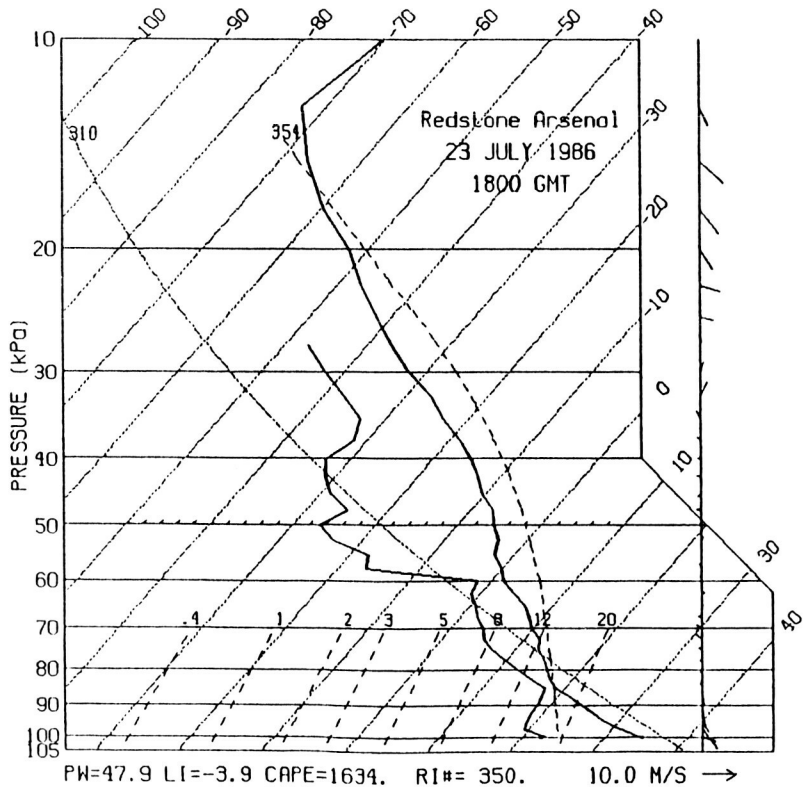


Fig. 3.2-52c. Redstone Arsenal, AL, rawinsonde sounding for 23 July 1986 1800 GMT

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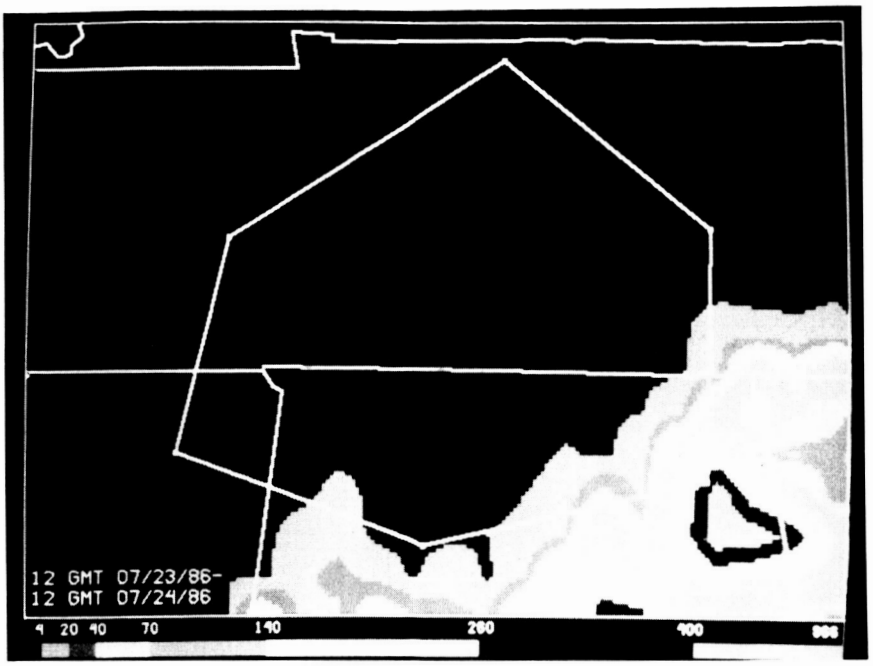


Fig. 3.2-52d. Twenty-four hour lightning strike density plot for 23-24 July 1986

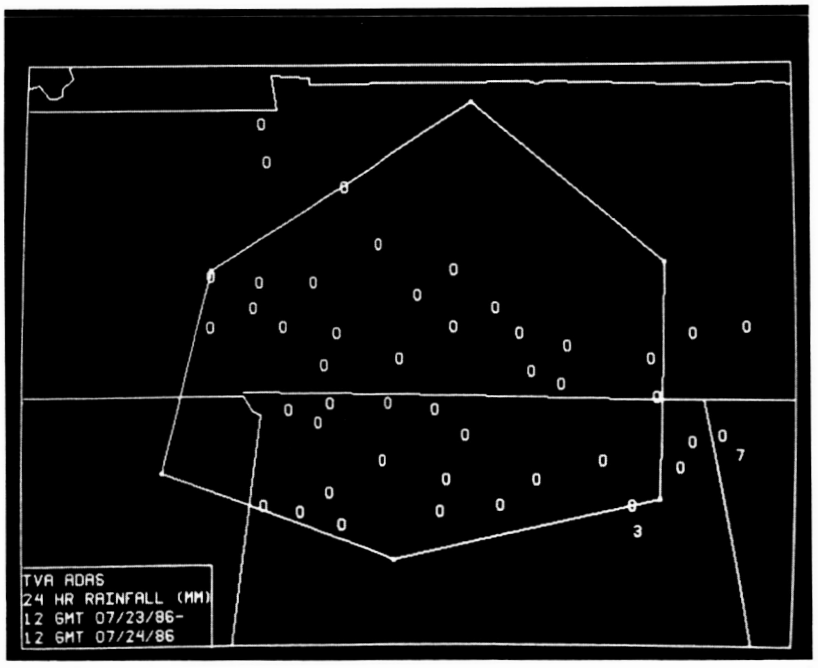


Fig. 3.2-52e. Twenty-four hour TVA ADAS rainfall totals (mm) for 23-24 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

24 July 1986

Synoptic Conditions

The subtropical ridge moved slowly eastward over the last 24 h and was centered over eastern Tennessee at 1200 GMT. Winds aloft increased only slightly and were still weak throughout the troposphere. Two short wave troughs appear in the 1200 GMT NMC 500 mb analysis. The NGM predicted these to move over the ridge north of the SPACE mesonet. Surface flow continued stagnant over the Southeast all day. Over the SPACE mesonet, winds were light northwesterly over the western portion, and light northeasterly over the eastern portion. Afternoon temperature and dewpoint values varied from a warm and dry 35 and 15 °C over the north to 34 and 19 °C over the southern mesonet.

Cloud/Precipitation Overview

First echoes formed around 1700 GMT 25-50 km south of CP-4. These intensified and expanded with other developing cells by 1830 GMT to form a scattered line nearly 200 km, oriented southwest to northeast. One relatively intense multicellular echo system within this line generated strong low level outflow and microbursts near 1900 GMT. It was closely examined by Doppler radar, the Citation (flying boxes) and the T-28. As outflow from this activity advanced northward over the MIST/FLOWS mesonet, additional thunderstorms were initiated. At 1945 GMT, a multicellular system 10 km northeast of CP-2 developed reflectivities to 55 dBZ and weak low level outflow. The intensity of convection weakened after 2100 GMT. During the evening hours a mesoscale convective system persisted over eastern Alabama and western Georgia.

Notes:

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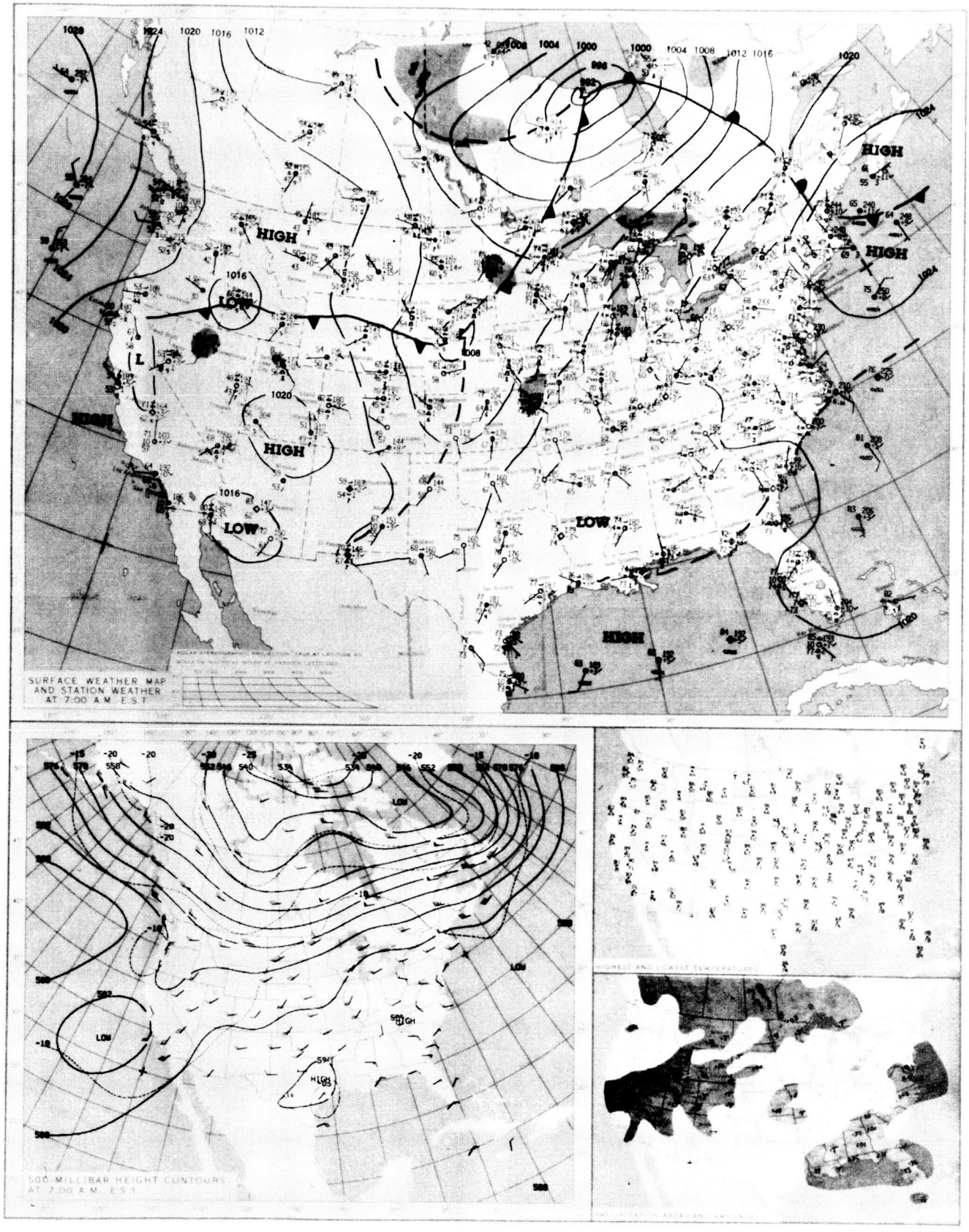


Fig. 3.2-53a. Synoptic weather conditions for 24 July 1986 1200 GMT

OPERATIONAL SUMMARY

24 July 1986

Rawinsonde Operations

The 1200 and 1800 GMT RSA soundings were taken.

Radar Operations

All Doppler radars were active during the afternoon. Only limited dual Doppler data were acquired on a moderately intense cell in the southeast CP-2/CP-3 lobe. CP-4 provided primarily surveillance scans, while CP-2 and CP-3 executed sectored PPI and RHI scans. FL-2 personnel logged 5 microburst events and one gust front from the afternoon activity.

Satellite Operations

All VAS products appear to be available through 1830 GMT, after which RISOP was started.

Aircraft Operations

The Citation, T-28 and Cessna 207 were active near the height of afternoon convective activity. The Citation sampled two cloud systems, one to the south of the MIST/FLOWS network and one just northeast of CP-2. Flight patterns were primarily boxes around clouds and penetrations through low level precipitation cores (one through a microburst). The T-28 penetrated the same two systems during the weakening stage of each. The 207 managed several passes through an outflow boundary 30 km west of CP-4.

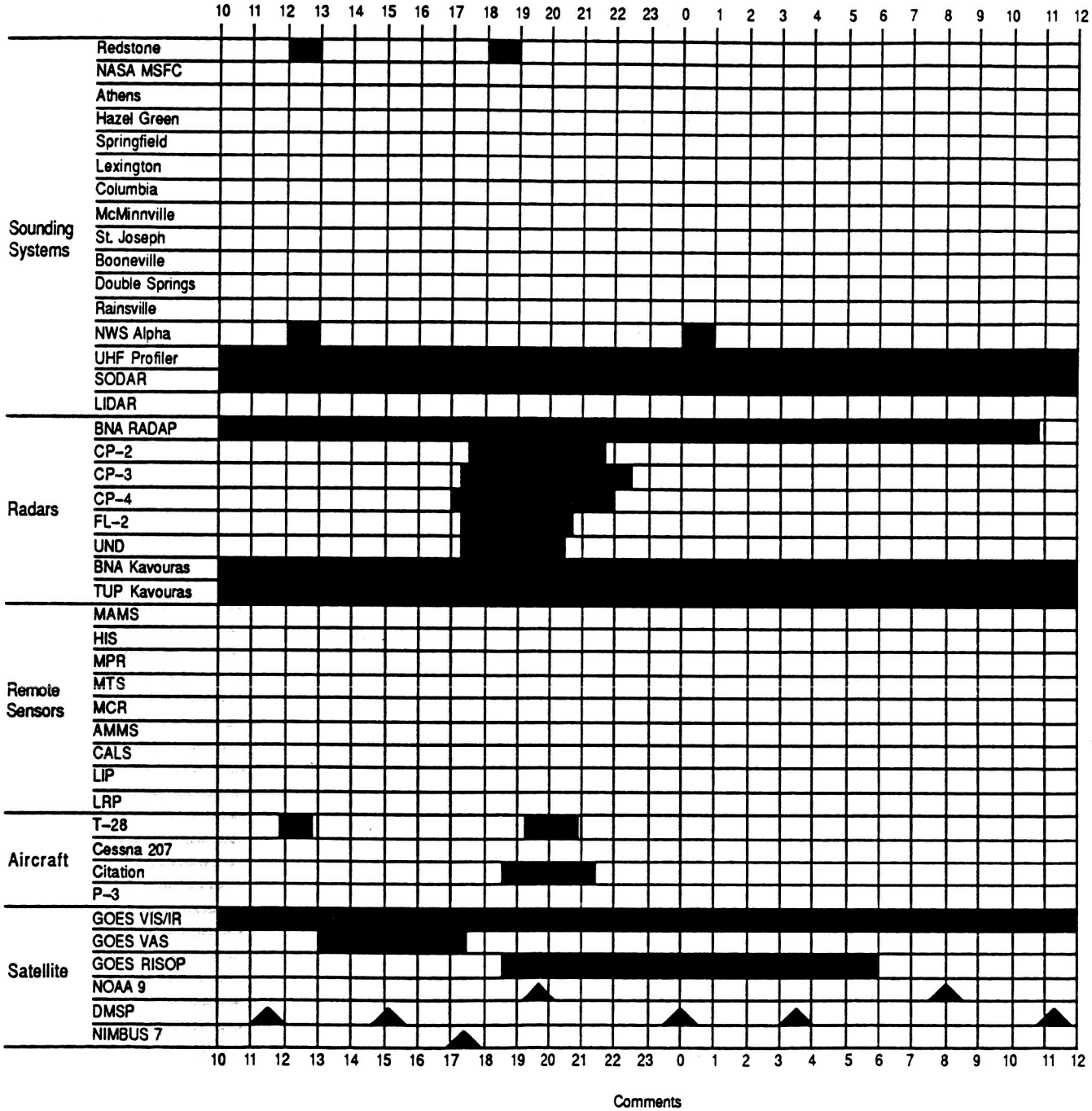
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5-550-7-8 (53)

Day: THURSDAY
Date: 7/24/86
Julian Day: 205–206

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	NO. 12 DOWN
	NAM	MISSING STATIONS 3 & 5
	TVA ADAS	MISSING STATIONS 21, 30, 32, 42, 45, 52, 56, 59, 62, & 63
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

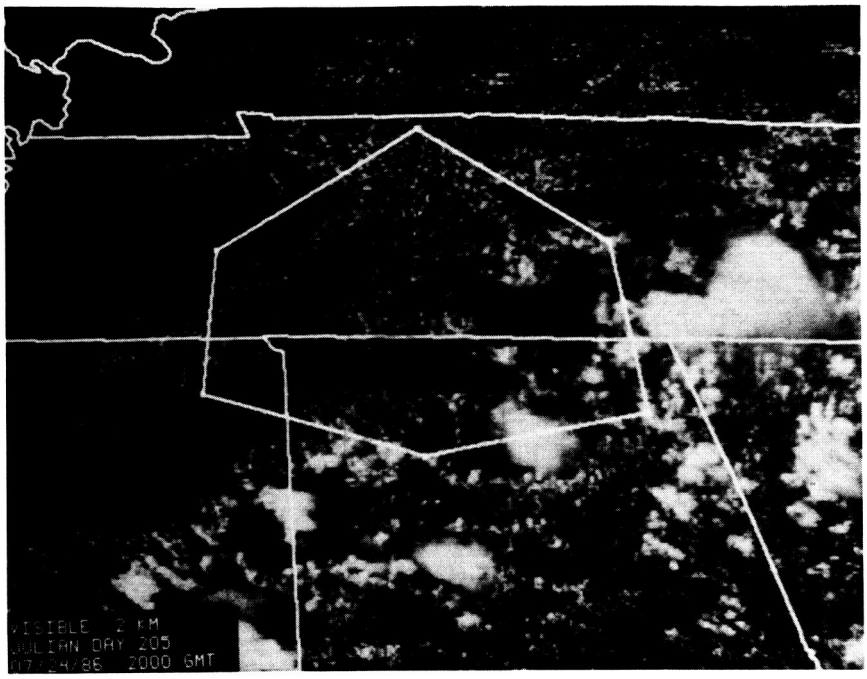


Fig. 3.2-53b. Visible 2 km GOES Central satellite image for 24 July 1986 2000 GMT

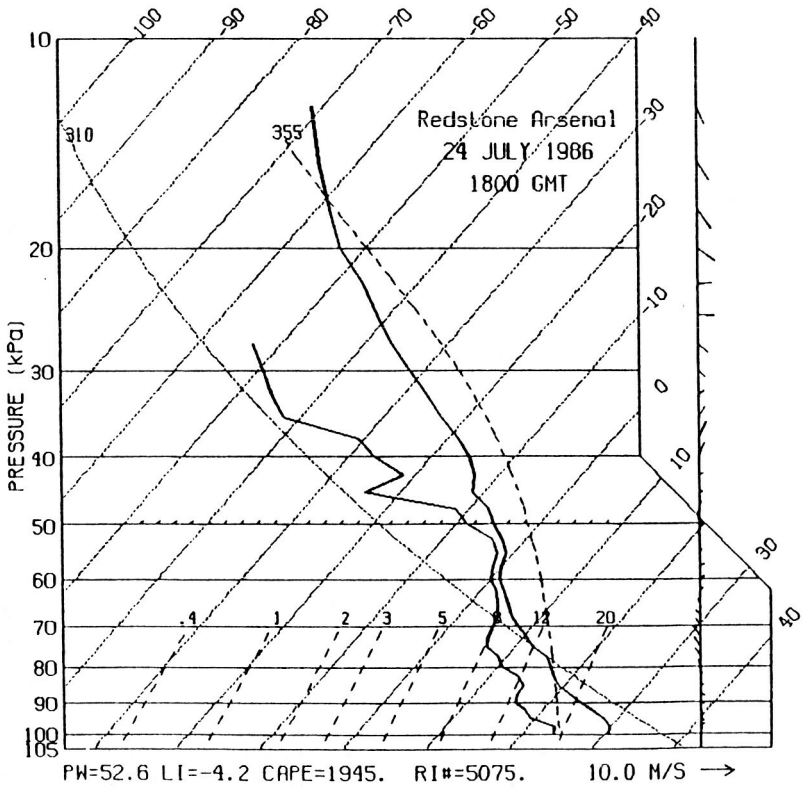


Fig. 3.2-53c. Redstone Arsenal, AL, rawinsonde sounding for 24 July 1986 1800 GMT

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Fig. 3.2-53d. Twenty-four hour lightning strike density plot for 24-25 July 1986

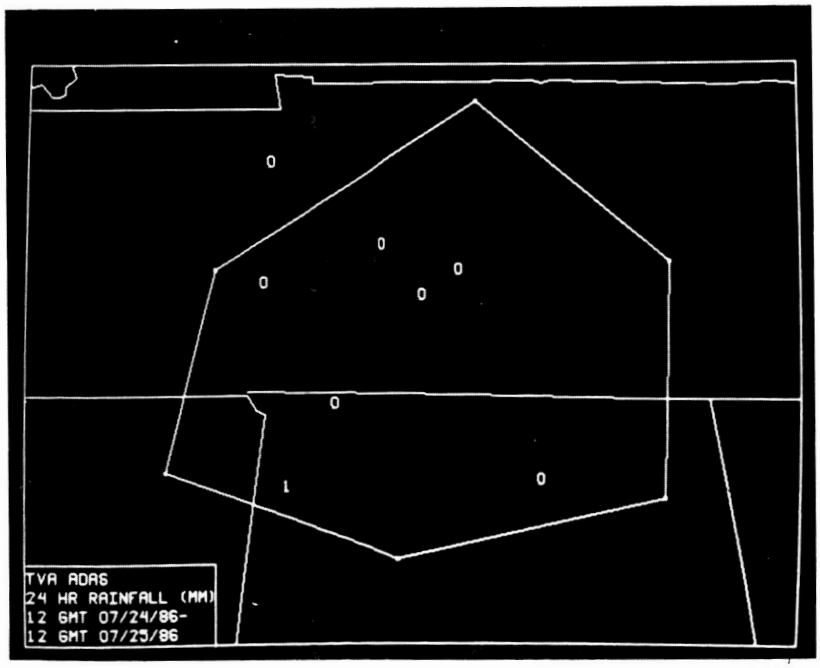


Fig. 3.2-53e. Twenty-four hour TVA ADAS rainfall totals (mm) for 24-25 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

25 July 1986

Synoptic Conditions

The broad upper level ridge, with its axis now extending from eastern Georgia to southwest Texas, remained over the Southeast but showed a southward drift over the past 24 h. Flow became more zonal over the SPACE mesonet in response to the ridge movement, but winds remained weak. Total buoyant potential energy of the 1800 GMT RSA sounding once again showed high values. At the surface over the SPACE mesonet, temperature and dewpoint values were relatively uniform, ranging from 35 and 20 °C over the north to 34 and 22 °C over the south. The surface dewpoint values increased by 2-3 °C from yesterday. Surface winds of 2-4 m s^{-1} varied in direction over the SPACE mesonet.

Cloud/Precipitation Overview

First echoes formed by 1700 GMT and attained locally intense reflectivity by 1800 GMT. From 1700 to 1900 GMT, echoes appeared to be isolated and scattered, after which apparent echo mergers produced two small, intense and more coherent thunderstorm complexes, one located over the central beta network from 2000 to 2200 GMT. The system to the south generated an outflow which moved northward over the MIST/FLOWS network. Scattered intense convective cells were generated both in advance of (10-20 km) and along the surface boundary. Echo tops and intensities of some intense cells were 15 km and 65 dBZ, respectively. Reflectivity factor values and low level outflow winds were generally stronger out of these storms than in the more isolated convection present earlier in the afternoon.

The system over the central beta network (studied in less detail) appeared to be very well structured and produced significant lightning. Convective intensity diminished after 2200 GMT. Rainfall amounts were generally scattered but locally heavy over the eastern 70% of the Meso-beta network.

Notes:

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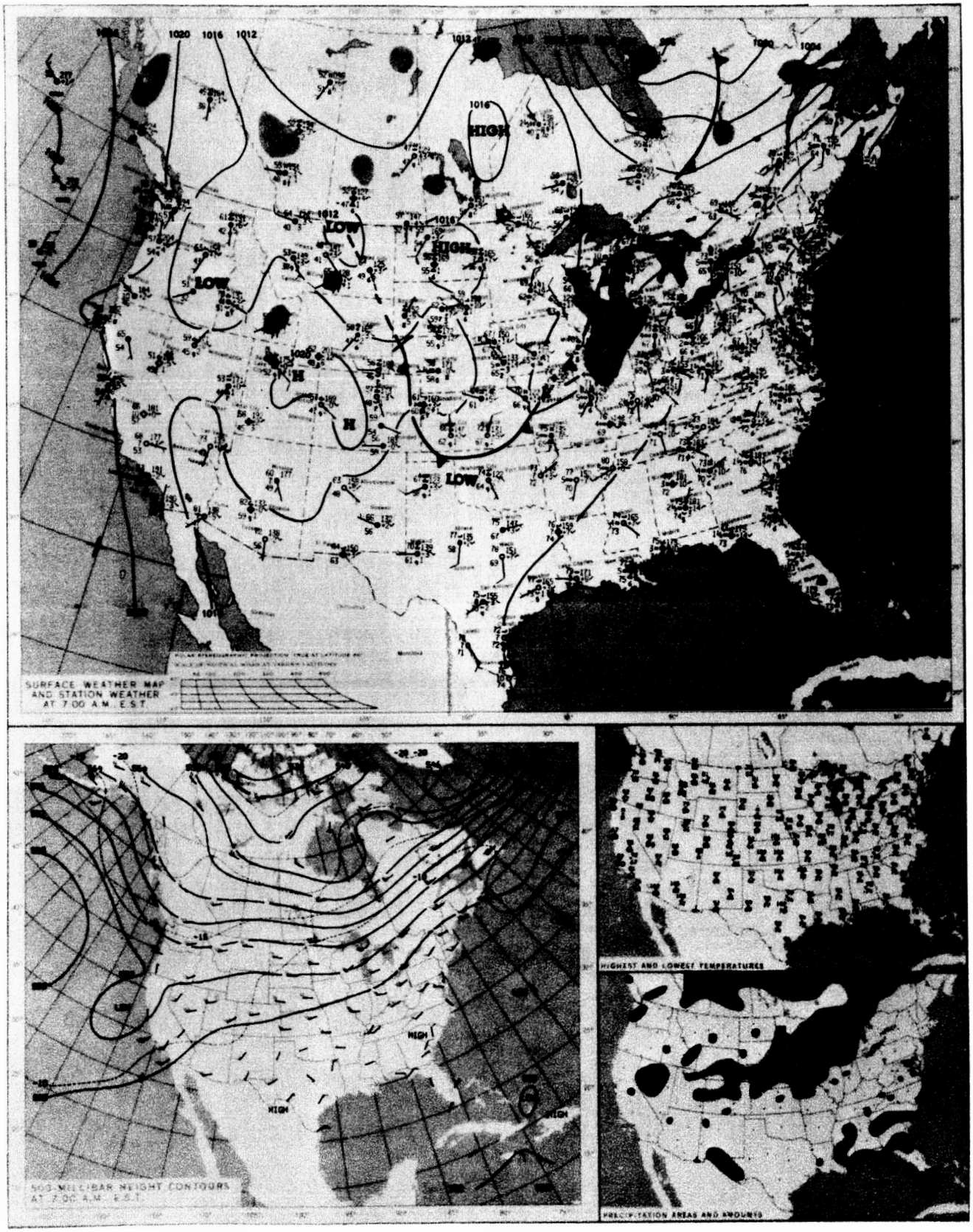


Fig. 3.2-54a. Synoptic weather conditions for 25 July 1986 1200 GMT

OPERATIONAL SUMMARY

25 July 1986

Rawinsonde Operations

The only special soundings were the 1200 and 1800 GMT RSA soundings.

Radar Operations

The Doppler radars were active from 1700 through 2300 GMT. A wide range of convective storm types were sampled during this time, including a lake breeze induced precipitating cloud, from 1820 to 1910 GMT, and other clouds to the south and west after 1915 GMT. Data were acquired in single Doppler mode during most of the afternoon. There appears to be no ideal multiple Doppler data from the NCAR radars, although some excellent single Doppler data were acquired.

FL-2 personnel logged seven microbursts during the afternoon hours, four of which exhibited velocity differentials of >20 m s^{-1}.

Satellite Operations

RISOP was started at 1830 GMT, approximately 90-min after first echo. In general, the organizing stages of convection over south central Tennessee and central Alabama should be well captured. GOES VAS products were archived through 1730 GMT.

Aircraft Operations

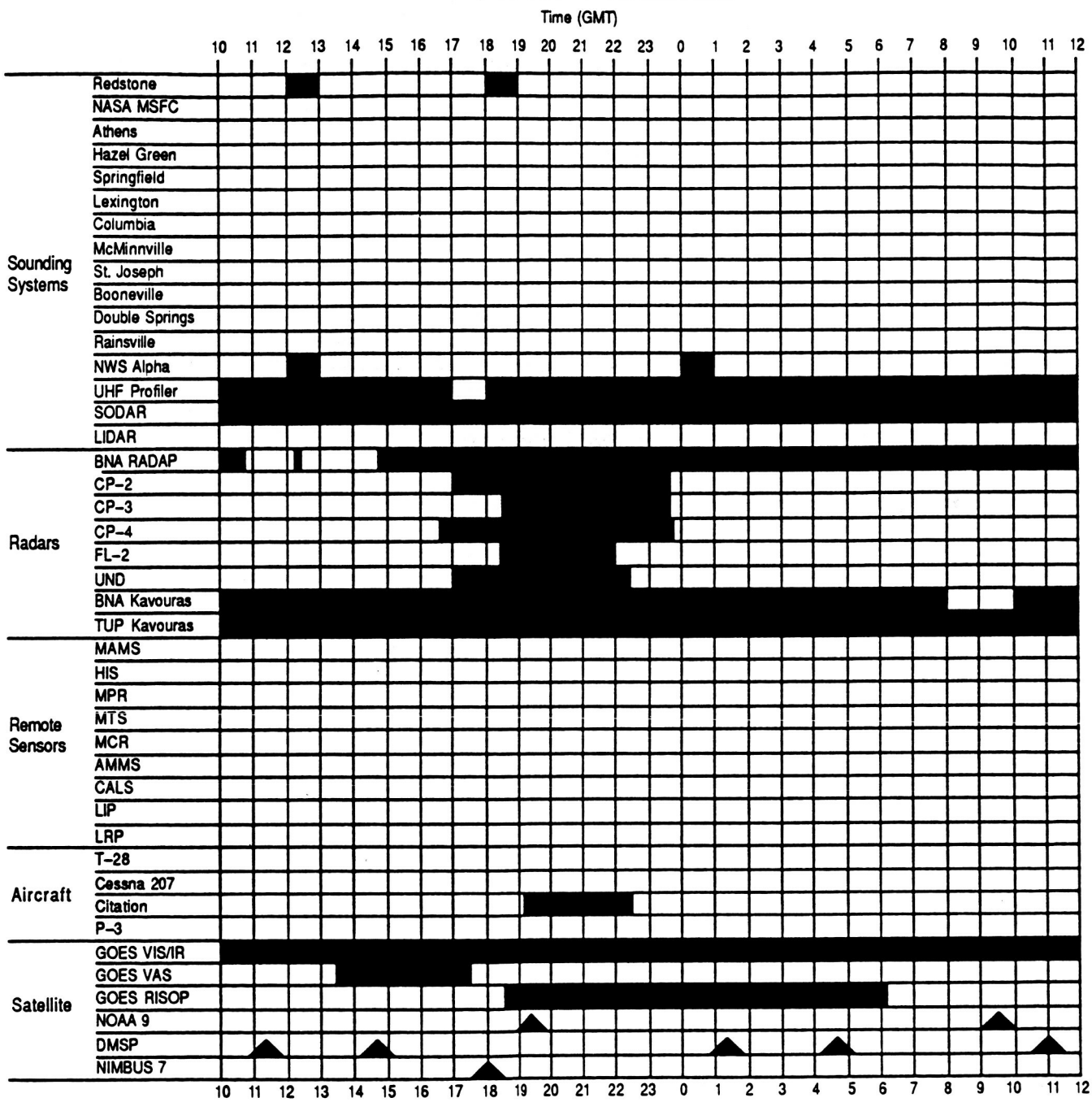
The Citation sampled several cloud systems during the afternoon hours. First, box patterns were flown at various levels around a relatively weak convective cloud, located along a Wheeler Lake breeze zone. During the last two hours, low level measurements were taken on an outflow system and associated deep convection that moved into the MIST/FLOWS area from the south. Penetrations were completed through three intense cells.

Notes:

5-550-7-8(54)

Day: FRIDAY
Date: 7/25/86
Julian Day: 206-207

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 3 & 5
	TVA ADAS	MISSING STATIONS 23, 30, 52, 59 & 62
	LLP	DF-2 DOWN, EFFECTIVE AT 2000 GMT
	Mobile Lab	NOT OPERATIONAL

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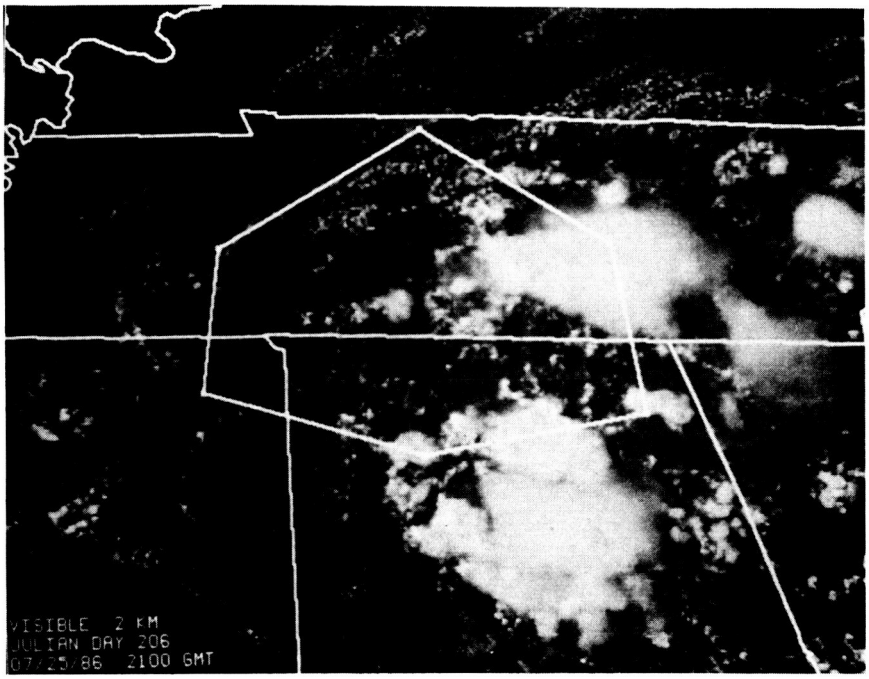


Fig. 3.2-54b. Visible 2 km GOES Central satellite image for 25 July 1986 2100 GMT

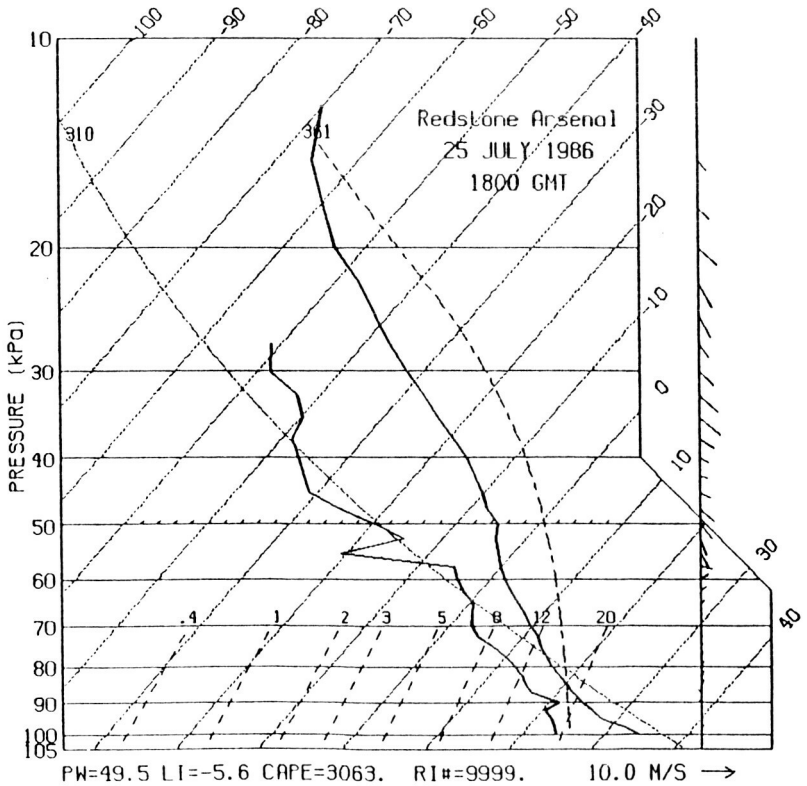


Fig. 3.2-54c. Redstone Arsenal, AL, rawinsonde sounding for 25 July 1986 1800 GMT

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Fig. 3.2-54d. Twenty-four hour lightning strike density plot for 25-26 July 1986

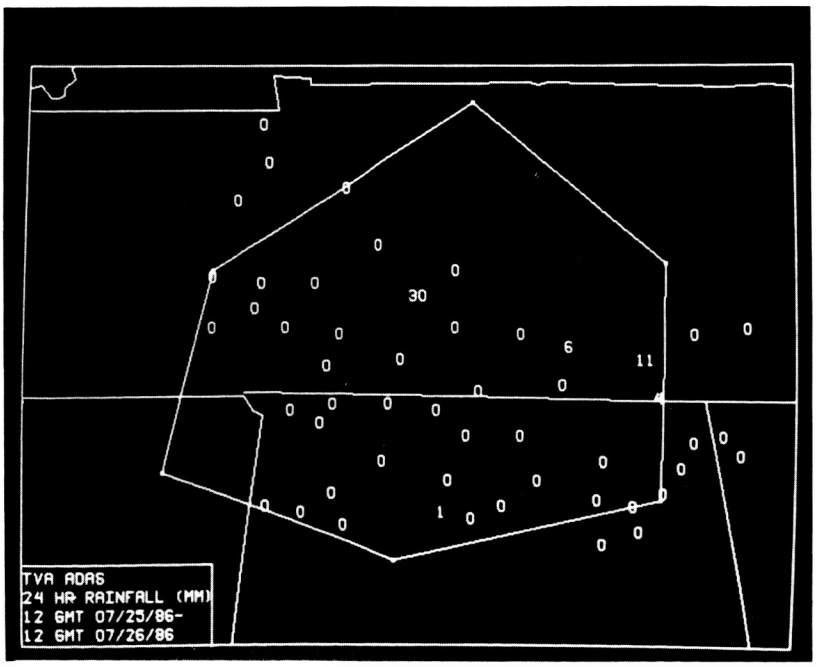


Fig. 3.2-54e. Twenty-four hour TVA ADAS rainfall totals (mm) for 25-26 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

26 July 1986

Synoptic Conditions

The upper level ridge showed a slow movement to the west during the last 24 h. At 1200 GMT the ridge axis extended from the southwestern SPACE mesonet towards the southwest into eastern Texas. Upper level winds over the SPACE mesonet were consequently weak and from the northwest. Total available buoyant energy on the 1800 GMT RSA sounding persisted at high levels. At the surface, the pressure gradient over the entire Southeast remained very weak. Afternoon temperature and dewpoint values over the SPACE mesonet ranged from 36 and 20 °C over the north to 34 and 22 °C over the southern boundary. Surface winds were westerly at 2-4 $m\ s^{-1}$.

Cloud/Precipitation Overview

Widely scattered thunderstorms developed primarily over the northern two-thirds of the SPACE mesonet during the afternoon hours. One cluster developed at ~1830 GMT near Muscle Shoals, and another (around 1900 GMT) 50 km east of CP-2. This latter thunderstorm exhibited a low level microburst divergence during its life cycle. Later on, a small MCS evolved over central Tennessee near 2000 GMT, initially being comprised of at least 10 weak reflectivity cells. This system subsequently displayed relatively high tops and reflectivity factor, and expanded to an MCS about 100 km in diameter. The system dissipated fairly quickly around 0000 GMT.

A final large MCS, which developed over southern Missouri, moved over the SPACE mesonet around 0300 GMT and dissipated over the network around 0600 GMT. This system exhibited an extensive region of trailing stratiform precipitation, and 2-3 groups of active convection along its forward (southeast) flank. This system also produced a prominent outflow and generated significant lightning. However, precipitation amounts were generally light and scattered.

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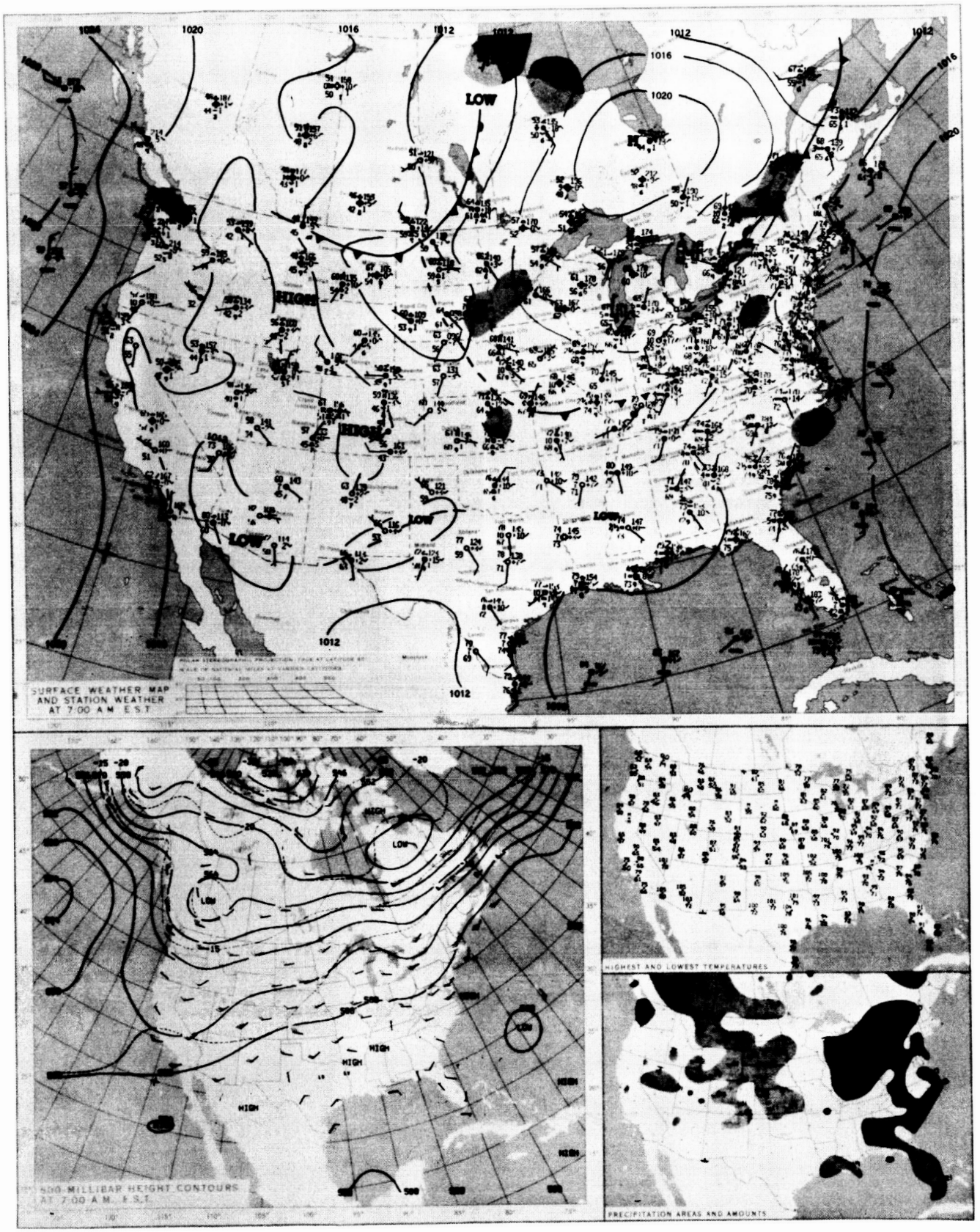


Fig. 3.2-55a. Synoptic weather conditions for 26 July 1986 1200 GMT

OPERATIONAL SUMMARY

26 July 1986

Rawinsonde Operations

A Meso-beta rawinsonde operation was started at 1500 GMT and continued at 3-h intervals until 0600 GMT. The middle to late afternoon small MCS over central Tennessee was probably well sampled by 3-4 stations at 2100 and 0000 GMT. However, sampling of the later MCS was marred by the absence of the 0600 GMT release from Lexington (weather related problems).

Radar Operations

Surveillance and other miscellaneous scans were conducted by the Doppler radars. CP-4 executed primarily surveillance scans up to 5° elevation throughout the afternoon. CP-2 provided more detailed coverage by utilizing sectored PPI and RHI scans of the convective activity over the northern SPACE mesonet. Because all activity was generally greater than 50 km from the MIST/FLOWS network, no dual Doppler data were acquired. All Doppler radars terminated operations before the arrival of the evening MCS over the northern SPACE mesonet. However, RADAP was operational throughout.

FL-2 implemented long-range NEXRAD full volume surveillance scans during the afternoon hours.

Satellite Operations

GOES VAS products were acquired up to 1730 GMT. RISOP began at 1830 GMT and should cover the complete evolution of the afternoon MCS over the northern SPACE mesonet.

Aircraft Operations

No operations.

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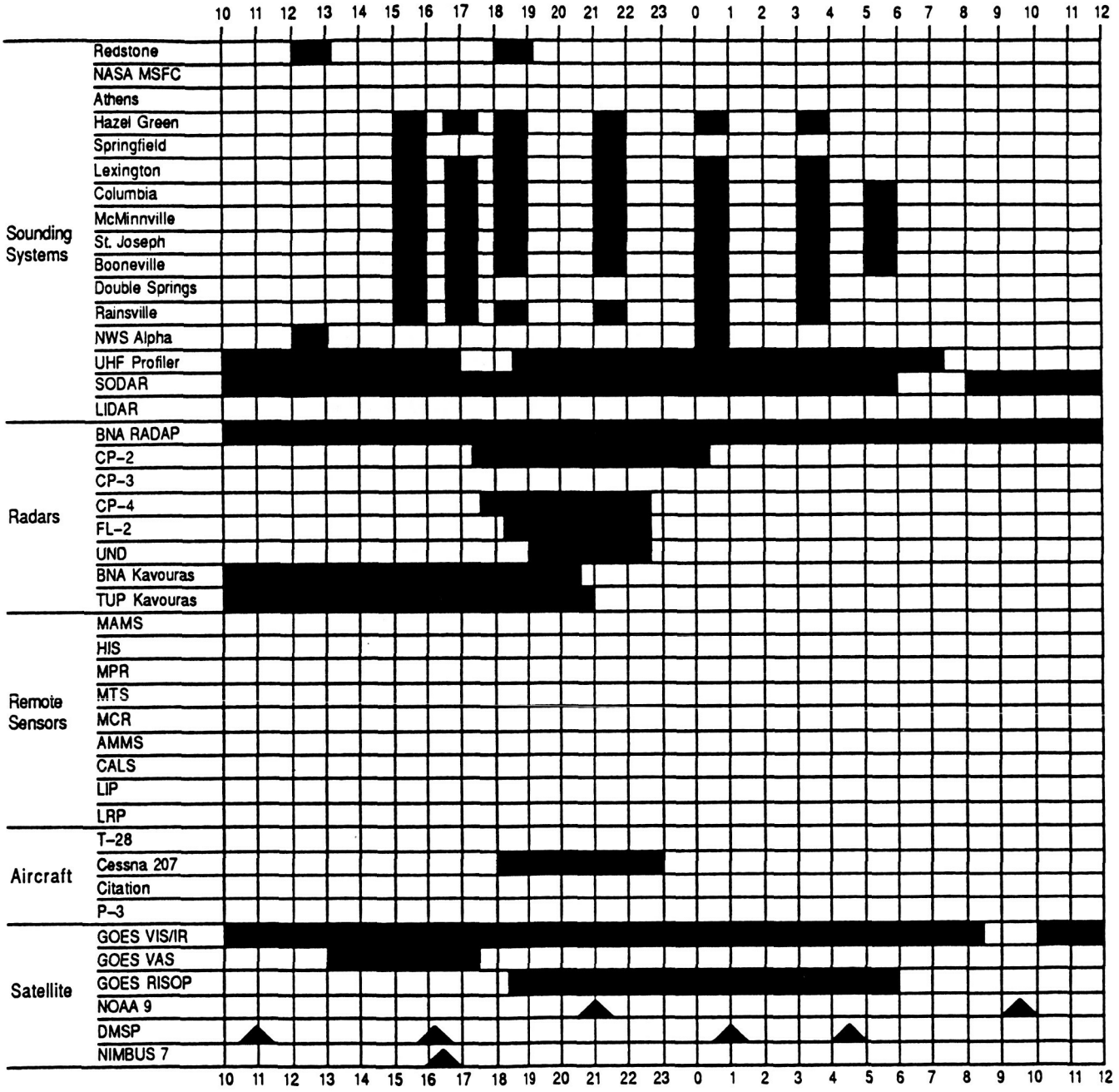
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5-550-7-8 (55)

Day: SATURDAY
Date: 7/26/86
Julian Day: 207–208

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 3 & 5
	TVA ADAS	MISSING STATIONS 21, 23, 45, 52, 59, & 62
	LLP	OK; DF-2 DOWN AT TIMES
	Mobile Lab	NOT OPERATIONAL

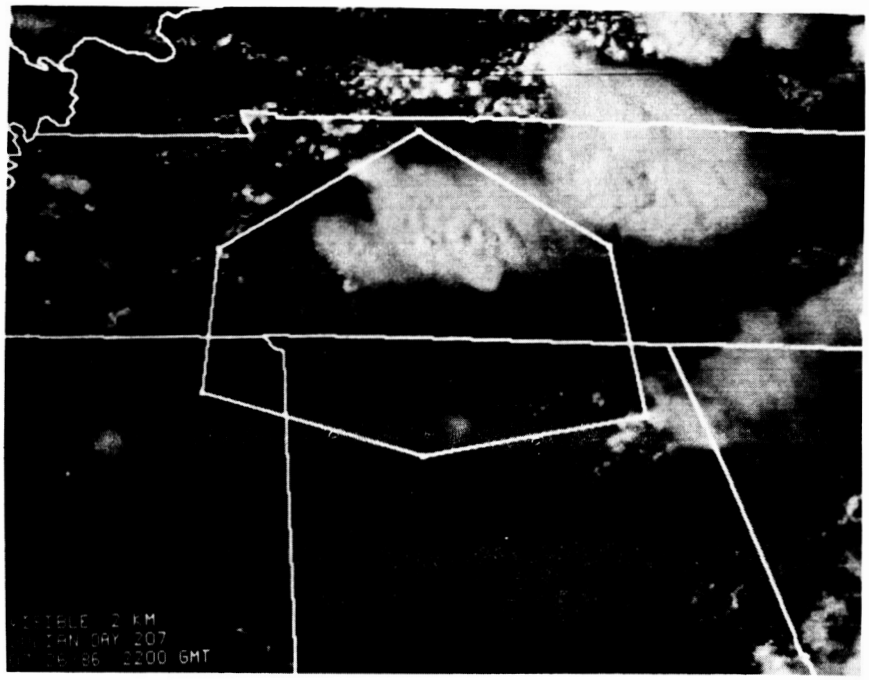


Fig. 3.2-55b. Visible 2 km GOES Central satellite image for 26 July 1986 2200 GMT

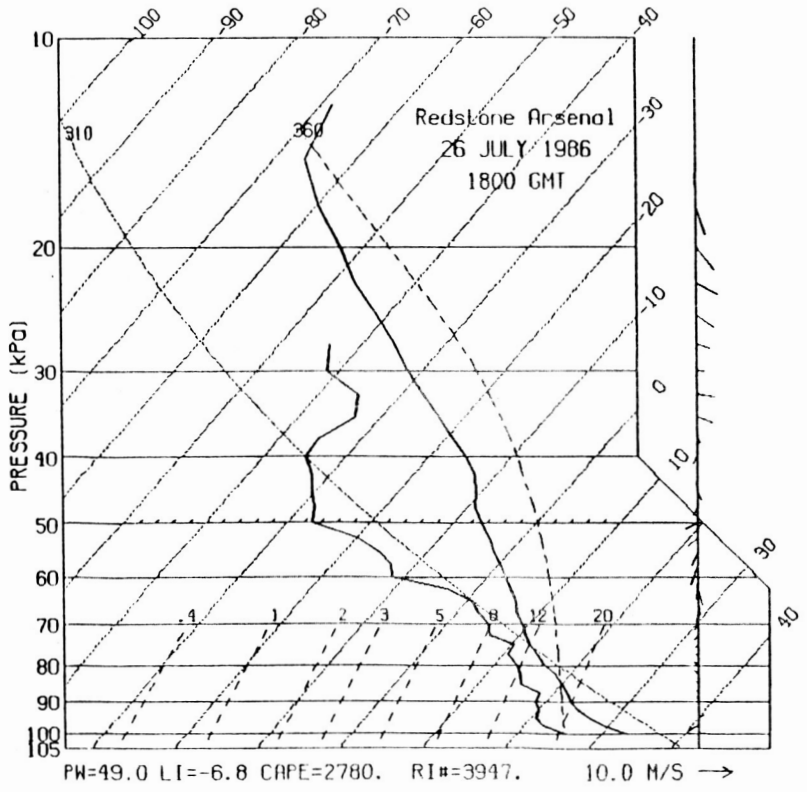


Fig. 3.2-55c. Redstone Arsenal, AL, rawinsonde sounding for 26 July 1986 1800 GMT

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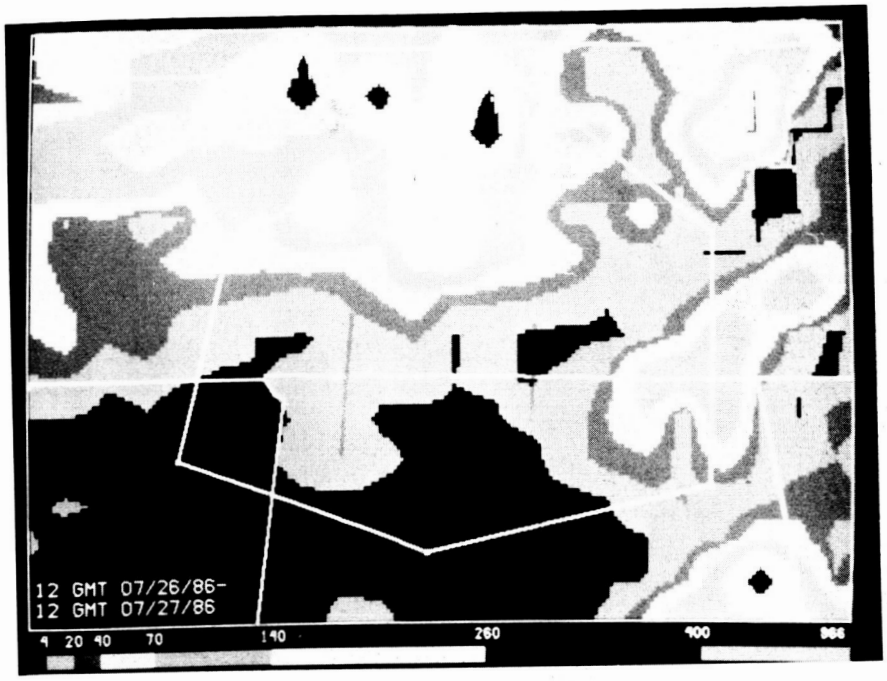


Fig. 3.2-55d. Twenty-four hour lightning strike density plot for 26-27 July 1986

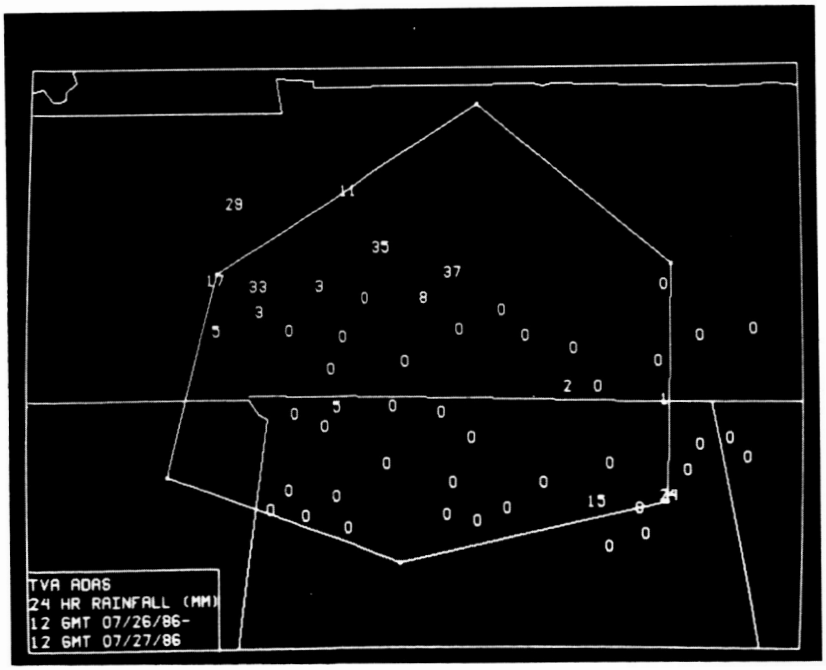


Fig. 3.2-55e. Twenty-four hour TVA ADAS rainfall totals (mm) for 26-27 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

27 July 1986

Synoptic Conditions

Although not indicated on the surface NMC analysis, a frontal passage, possibly created by last night's MCS, appeared to have taken place over the SPACE mesonet. Stabilization and drying at the surface transpired over the mesonet during the afternoon hours. At 500 mb, a short wave trough was located over the northern mesonet at 1200 GMT. The upper level ridge continued to intensify over Oklahoma and Texas. Upper level winds over the mesonet were generally westerly at 5-8 m s^{-1}. At the surface, temperature and dewpoint values ranged from 21-28 °C over the northern mesonet to 17-23 °C over the south. Surface flow was 5 m s^{-1}.

Cloud/Precipitation Overview

This was a remarkably clear and nearly cloud free day over most of the SPACE mesonet. Cumulus mediocris clouds developed by late morning but dissipated during the afternoon hours as lower level moisture decreased. Thunderstorm activity was common over the southern half of Alabama and Mississippi, and over much of Georgia.

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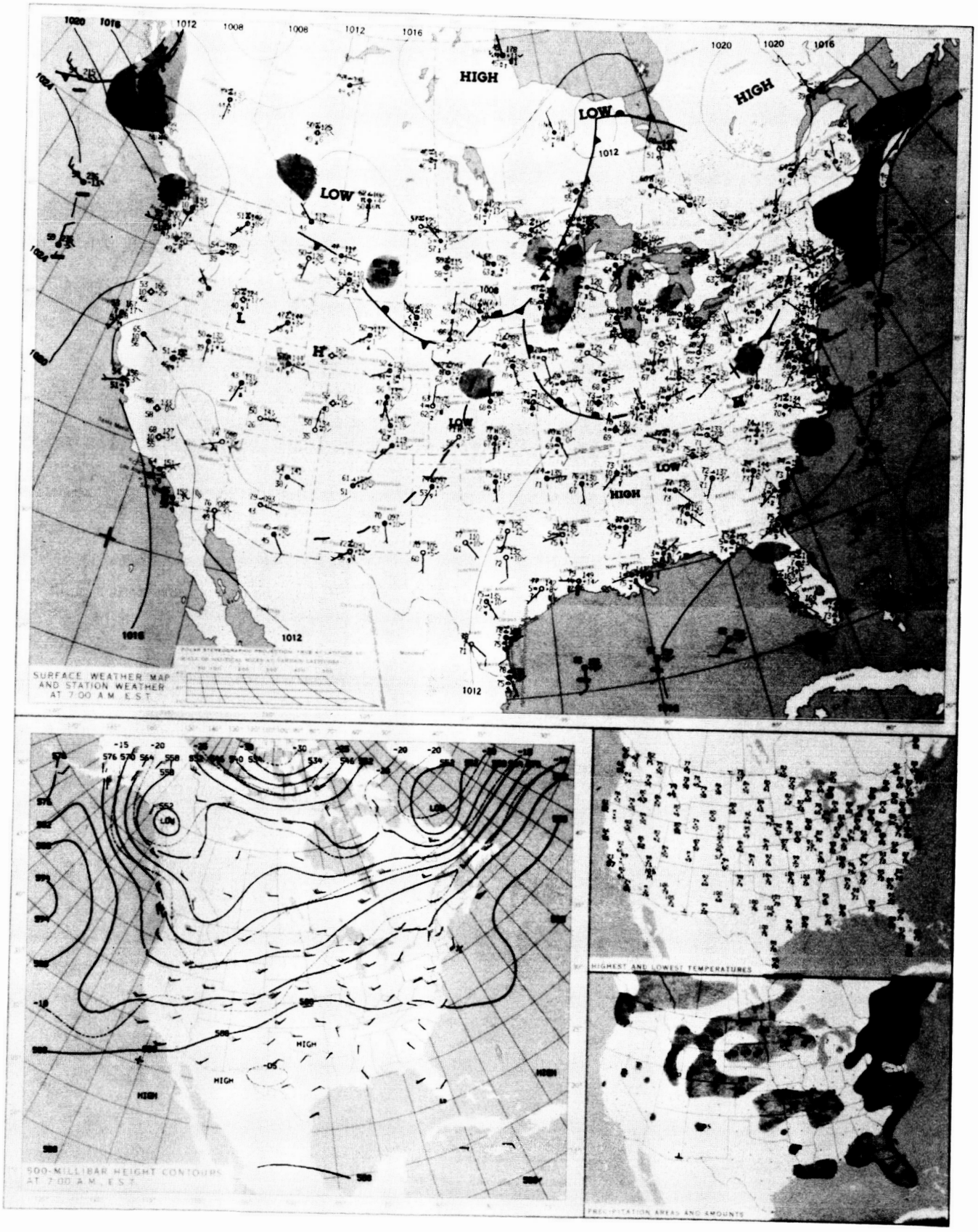


Fig. 3.2-56a. Synoptic weather conditions for 27 July 1986 1200 GMT

OPERATIONAL SUMMARY

27 July 1986

Rawinsonde Operations

A Meso-beta rawinsonde operation was effected at 1800 GMT and terminated after the 2100 GMT release.

Radar Operations

Radars were on standby from early to middle afternoon. CP-4 recorded surveillance scans. The Wheeler Lake breeze zone was apparent in radial velocity patterns. Precipitating convection within CP-4 range (115 km) was most common in the southeast quadrant, where cells as close as 50 km existed.

Satellite Operations

GOES RISOP was started relatively early at 1400 GMT. However, these data will be of little use for analyses over the SPACE mesonet due to lack of clouds.

Aircraft Operations

No operations.

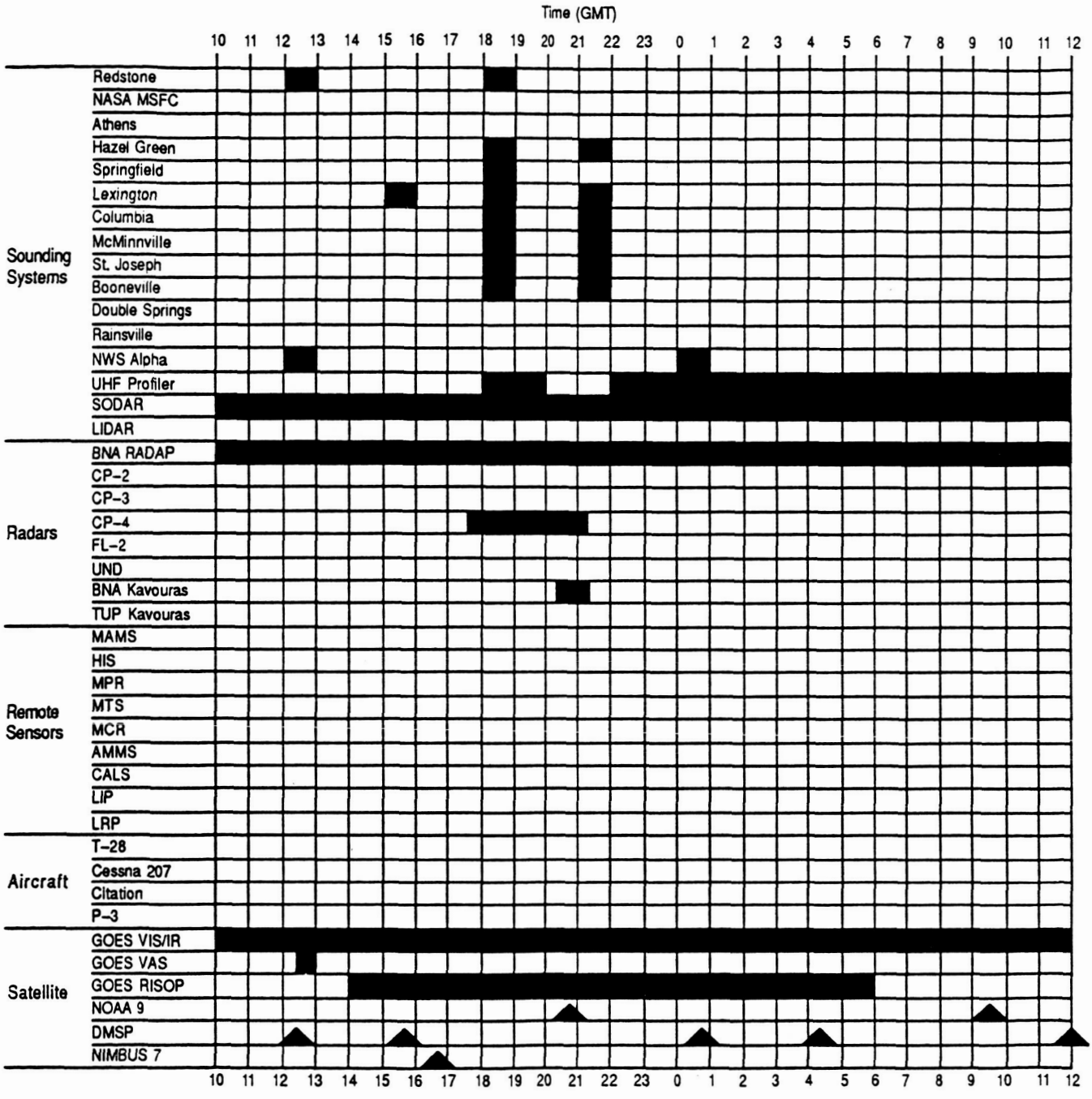
Notes:

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Day: SUNDAY
Date: 7/27/86
Julian Day: 208–209

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 3 & 5
	TVA ADAS	MISSING STATIONS 21, 23, 52, 59 & 62
	LLP	DF–2 DOWN AFTER 2000 GMT
	Mobile Lab	NOT OPERATIONAL

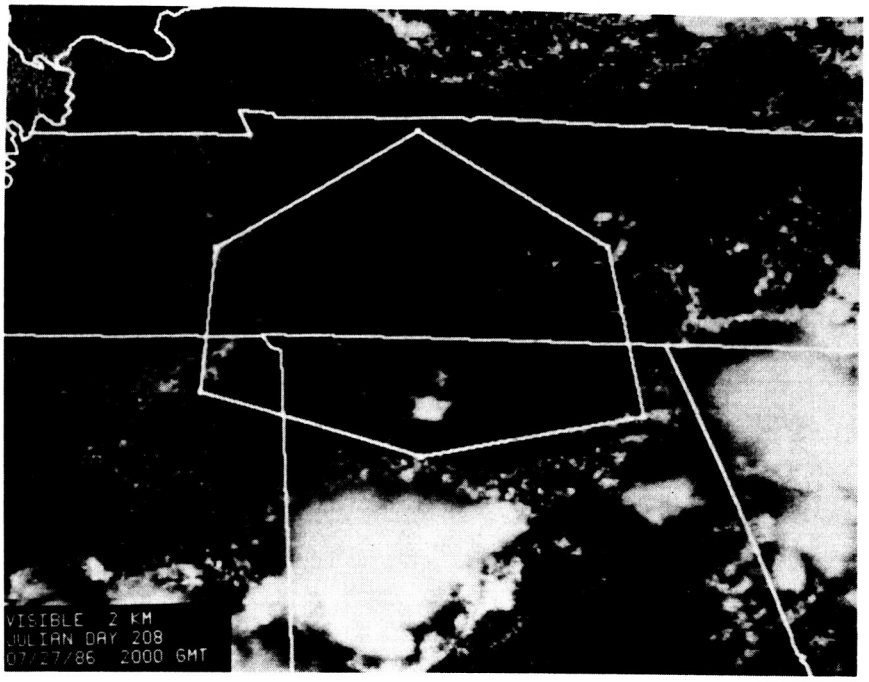


Fig. 3.2-56b. Visible 2 km GOES Central satellite image for 27 July 1986 2000 GMT

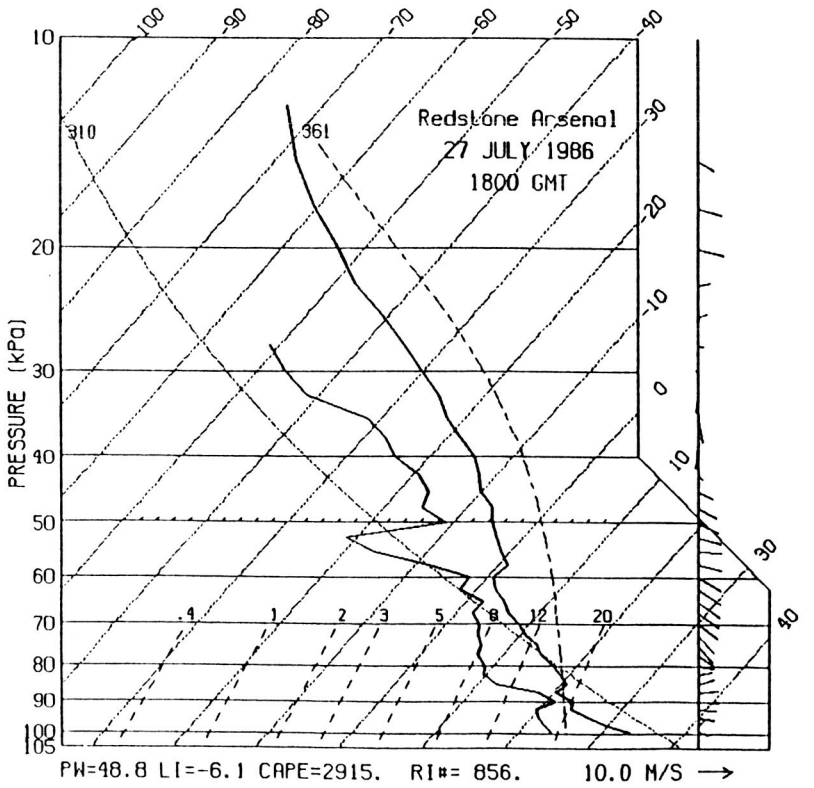


Fig. 3.2-56c. Redstone Arsenal, AL, rawinsonde sounding for 27 July 1986 1800 GMT

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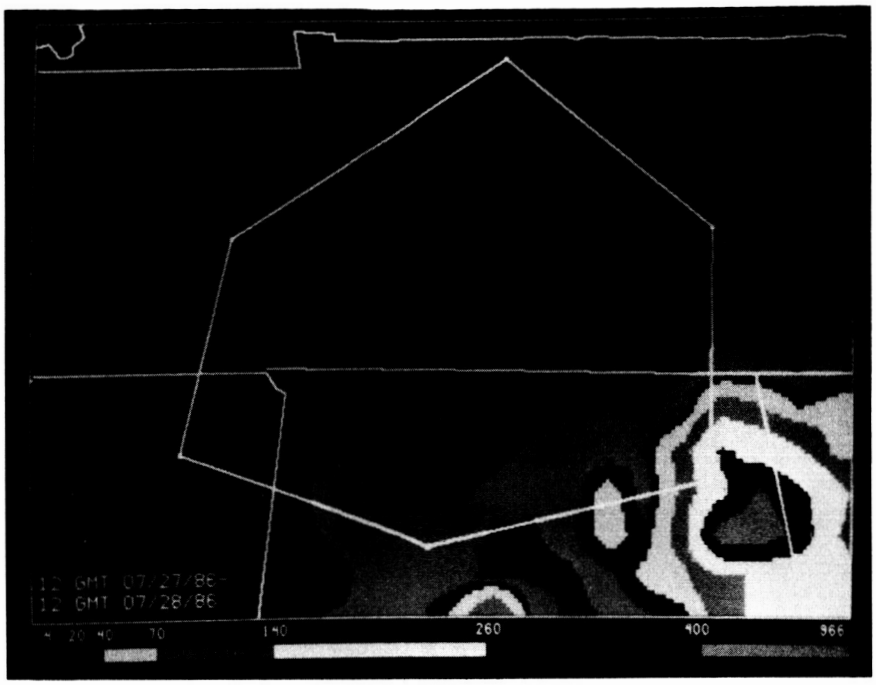


Fig. 3.2-56d. Twenty-four hour lightning strike density plot for 27-28 July 1986

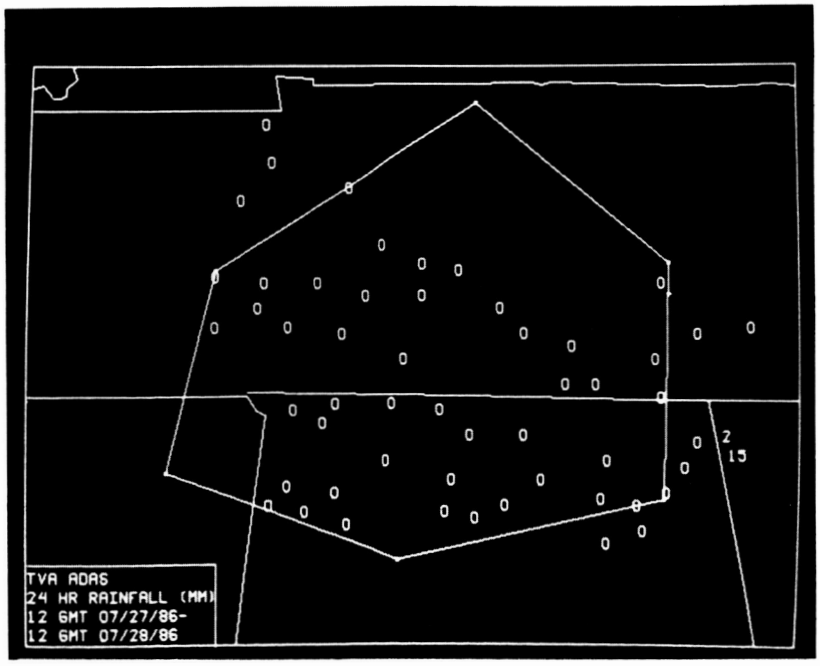


Fig. 3.2-56e. Twenty-four hour TVA ADAS rainfall totals (mm) for 27-28 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

28 July 1986

Synoptic Conditions

Northwesterly flow aloft intensified to 15 m s^{-1} over the SPACE mesonet as the upper level ridge continued to build over Texas and Oklahoma. Surface features on the synoptic scale remained benign over the Southeast. To the north of the mesonet over Kentucky, a squall line was in progress at 1200 GMT, and a cold outflow boundary from this system approached the Tennessee-Kentucky border. The air mass over the mesonet remained unstable, and total precipitable water increased by 7 mm over yesterday. Surface temperature and dewpoint values over the mesonet were uniform at 35-36 °C and 22 °C, respectively, in the presence of 3-6 m s^{-1} westerly flow. Flow patterns over the mesonet during the afternoon appeared to be convergent.

Cloud/Precipitation Overview

Stratocumulus clouds were observed over the HSV area at 1200 GMT. These clouds dissipated by midmorning and were replaced by cumulus congestus clouds which developed by 1700 GMT. An early morning MCS moved southeastward through Kentucky from 1200 to 1700 GMT, skirting the northern border of the SPACE mesonet.

Widely scattered weak to moderately intense convective cells were located over the SPACE network through 2000 GMT, but this activity showed a decrease in intensity from 2000 to 2200 GMT over the entire network. Cells observed by radar near the MIST/FLOWS network appeared to form along an outflow boundary that progressed from old convection (to the northeast) towards the southwest. Although observed echo tops were in the 7-10 km range, low level divergence in the range of 10-15 m s^{-1} was observed in 2 cells.

Around 2200 GMT, thunderstorms developed explosively out of two enhanced east-west bands of cumulus located over south central Tennessee and over north central Tennessee. The storms over south central Tennessee subsequently expanded to form two areas of very intense convection by 0100 GMT, one north of to very near HSV and the other just southeast of BNA. Observed echo tops were near 18 km and reflectivity factor exceeded 65 dBZ. These storms produced strong surface winds, hail up to 2 cm in diameter, and copious amounts of lightning. Inter-cloud lightning within the anvils of the HSV storms was nearly continuous around 0200 GMT. A tornado touched down just east of Green Mountain, 8 miles southeast of Huntsville, Al. The tornado moved south-southeast through farm fields along Big Cove Road. Aerial and ground, post-storm surveys revealed that the tornado left a cyclonic swirling pattern in a hay field.

Notes:

28 July 1986

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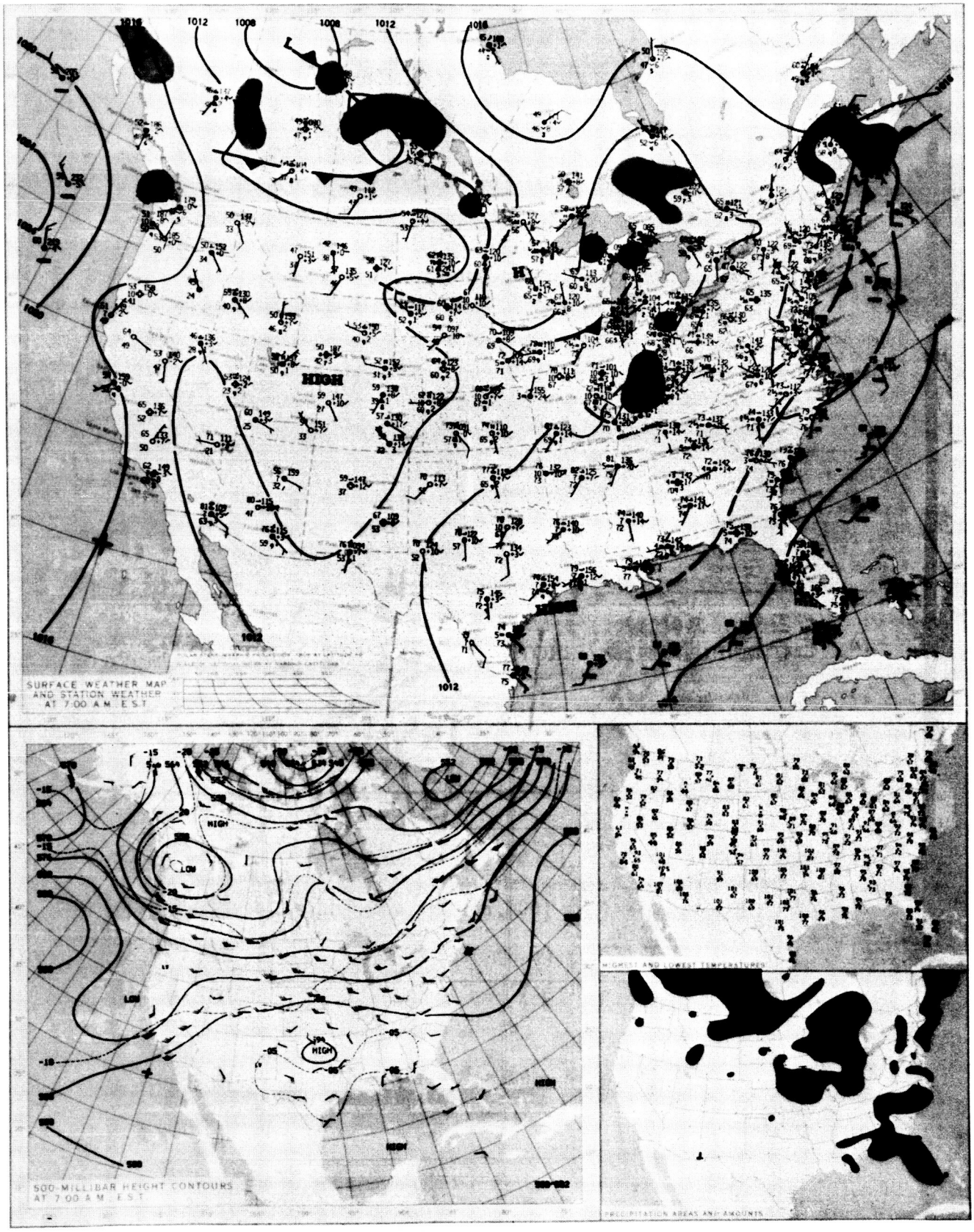


Fig. 3.2-57a. Synoptic weather conditions for 28 July 1986 1200 GMT

OPERATIONAL SUMMARY

28 July 1986

Rawinsonde Operations

The only special operations acquired were the default 1200 and 1800 GMT RSA soundings.

Radar Operations

From 1730 to 2200 GMT, the Doppler radars conducted miscellaneous scans on weak to moderate convection in the local area. Dual Doppler scans were acquired on several of these afternoon cells. The initial portion of the late afternoon activity was missed by all Doppler radars because the explosive growth was not anticipated. FL-2 began recording around 2300 GMT, but the NCAR radars did not resume operations until the storm mature phase around 0100 GMT. Only limited dual Doppler data appear to have been acquired during the intense evening convection. FL-2 personnel logged at least seven microbursts during the day.

Satellite Operations

GOES VAS products were acquired only through 1430 GMT. This time may be too early to uncover any PBL irregularities that initiated the intense late afternoon to early evening thunderstorms. However, RISOP covers the development of this activity.

Aircraft Operations

The Cessna 207, the only operational aircraft, acquired data in conjunction with the Doppler radars over the western portion of the multiple Doppler radar coverage area. A detectable PBL convergence zone and associated precipitation cells were penetrated at several levels. There should be some good data on cell initiation by PBL convergence in this data set.

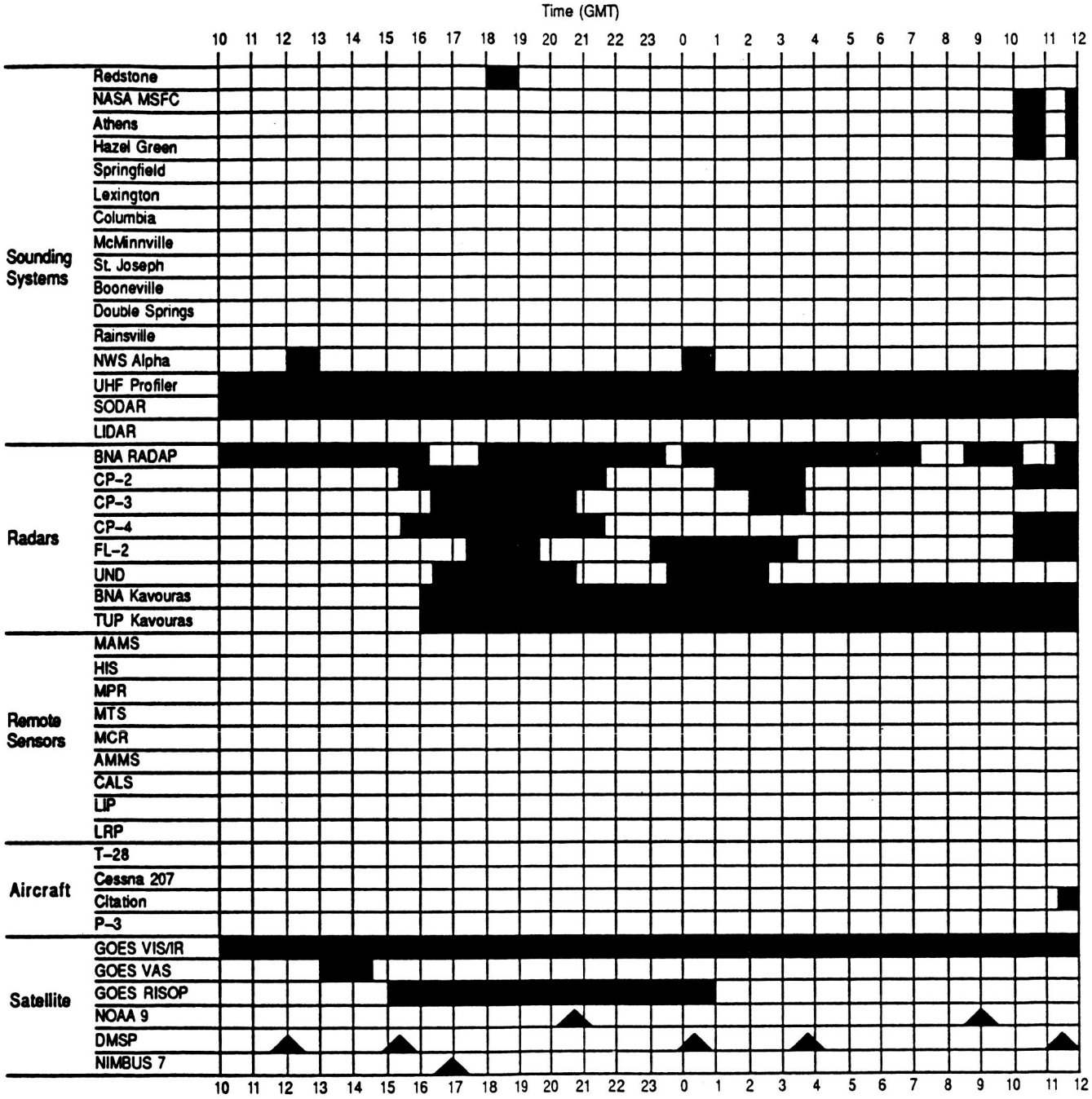
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5-550-7-8(57)

Day: MONDAY
Date: 7/28/86
Julian Day: 209–210

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 21, 23, 45, 52, 59 & 62
	LLP	DF– 2 NOT OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

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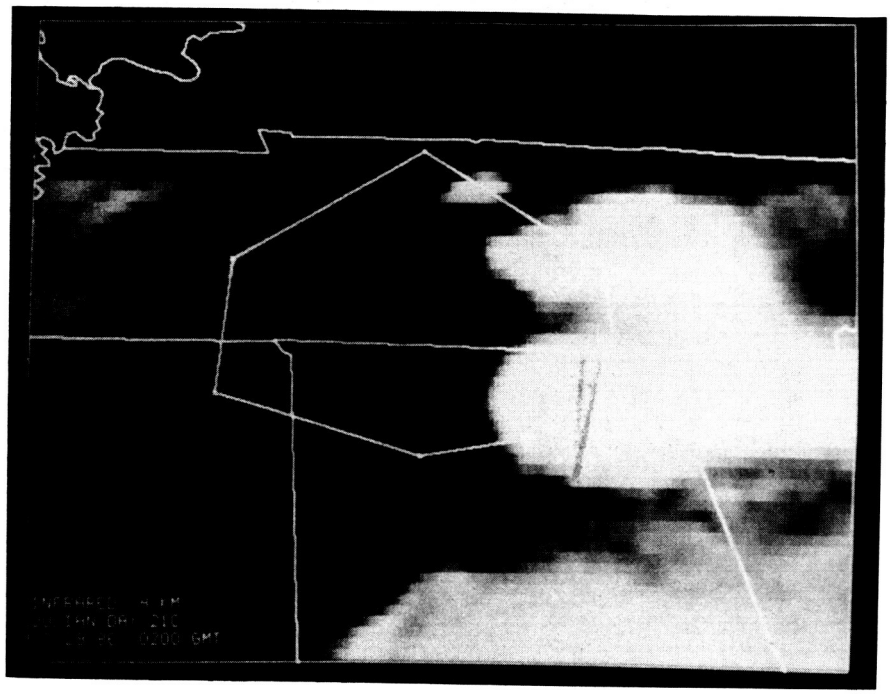


Fig. 3.2-57b. Infrared 4 km GOES Central satellite image for 28 July 1986 0200 GMT

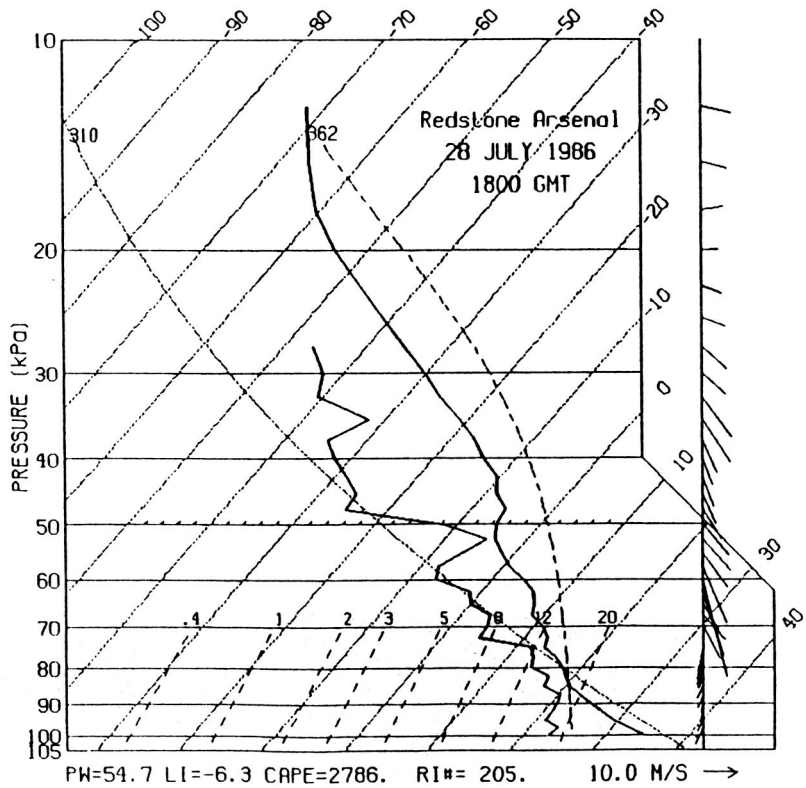


Fig. 3.2-57c. Redstone Arsenal, AL, rawinsonde sounding for 28 July 1986 1800 GMT

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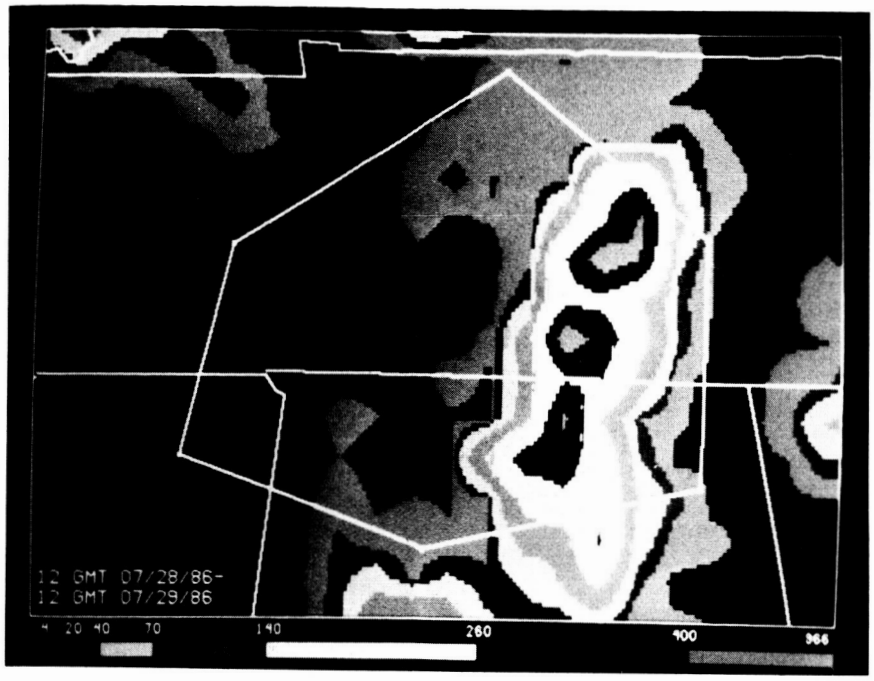


Fig. 3.2-57d. Twenty-four hour lightning strike density plot for 28-29 July 1986



Fig. 3.2-57e. Twenty-four hour TVA ADAS rainfall totals (mm) for 28-29 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

29 July 1986

Synoptic Conditions

Northwesterly flow aloft continued over the SPACE mesonet in response to continued strengthening of the ridge located over Texas and Oklahoma. Winds aloft over the mesonet increased to 20 m s^{-1} at 500 mb on the 1200 GMT RSA sounding. However, considerable drying took place over past 24-h, with precipitable water on the 1800 GMT RSA sounding having dropped by 20 mm over yesterday's value. Over the last 24-h, a weak surface anticyclone managed to push a subtle cold front into the northern mesonet during the morning hours. Afternoon temperature and dewpoint values over the mesonet ranged from a very warm 37 and 18 °C reading over the southwest mesonet, to ~35 and 21 °C elsewhere. Winds were primarily from the northeast at 3-5 m s^{-1}.

Cloud/Precipitation Overview

Cumulus mediocris clouds formed and became widespread by late morning, but thinned considerably by early afternoon as dry air from aloft was mixed to lower levels. A small cluster of echoes formed over the northwest SPACE network around 1900 GMT. This area, however, dissipated by 2100 GMT as it moved over drier low level air over the central mesonet. Limited lightning was produced by this mostly weak convective activity.

Notes:

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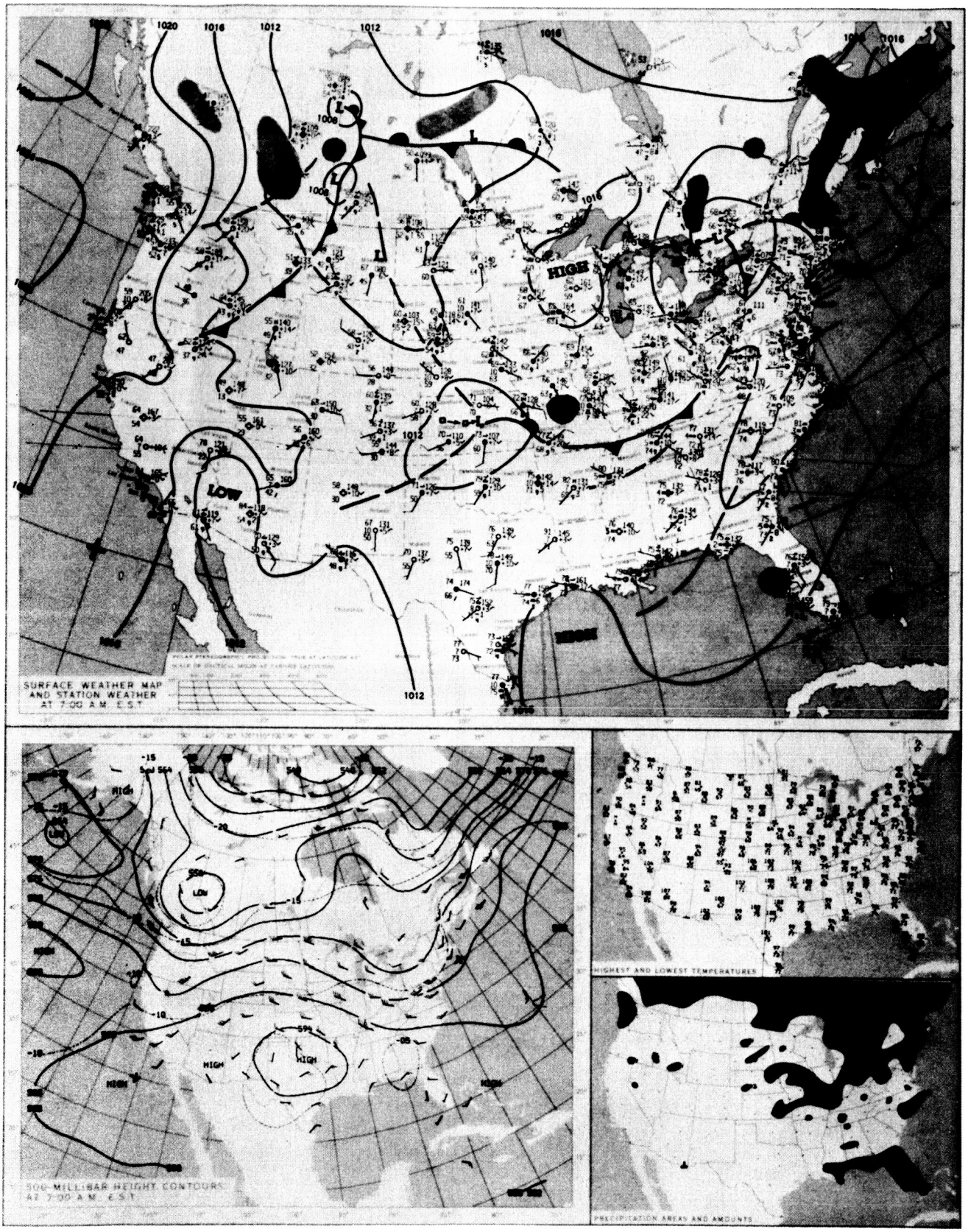


Fig. 3.2-58a. Synoptic weather conditions for 29 July 1986 1200 GMT

OPERATIONAL SUMMARY

29 July 1986

Rawinsonde Operations

A 3 station Meso-gamma rawinsonde operation was conducted from 0900 to 1630 GMT, at 90-min intervals, in support of a general PBL (bird/bug) experiment. During the afternoon hours a high frequency (90-min) limited Meso-beta operation was activated from 2100 through 0130 GMT. Precipitating convection over the central SPACE mesonet subsided during this time.

Radar Operations

An intensive clear air study was conducted by CP-2 and CP-4 from 0900 to about 2030 GMT. A combination of sectored PPI, RHI and VAD scans were cycled every 30-min in a virtually continuous fashion during this period. A complete boundary layer evolution appeared to be captured, from pre-dawn stagnant conditions, to a well developed, mature afternoon PBL. Supplemental data are also available from FL-2, UND, the SODAR and the UHF profiler during the early morning to afternoon period.

Satellite Operations

GOES VAS products were acquired through 1730 GMT, after which RISOP was started.

Aircraft Operations

The Citation conducted a bug/PBL study from 1115 to 1345 GMT in coordination with the FL-2 radar.

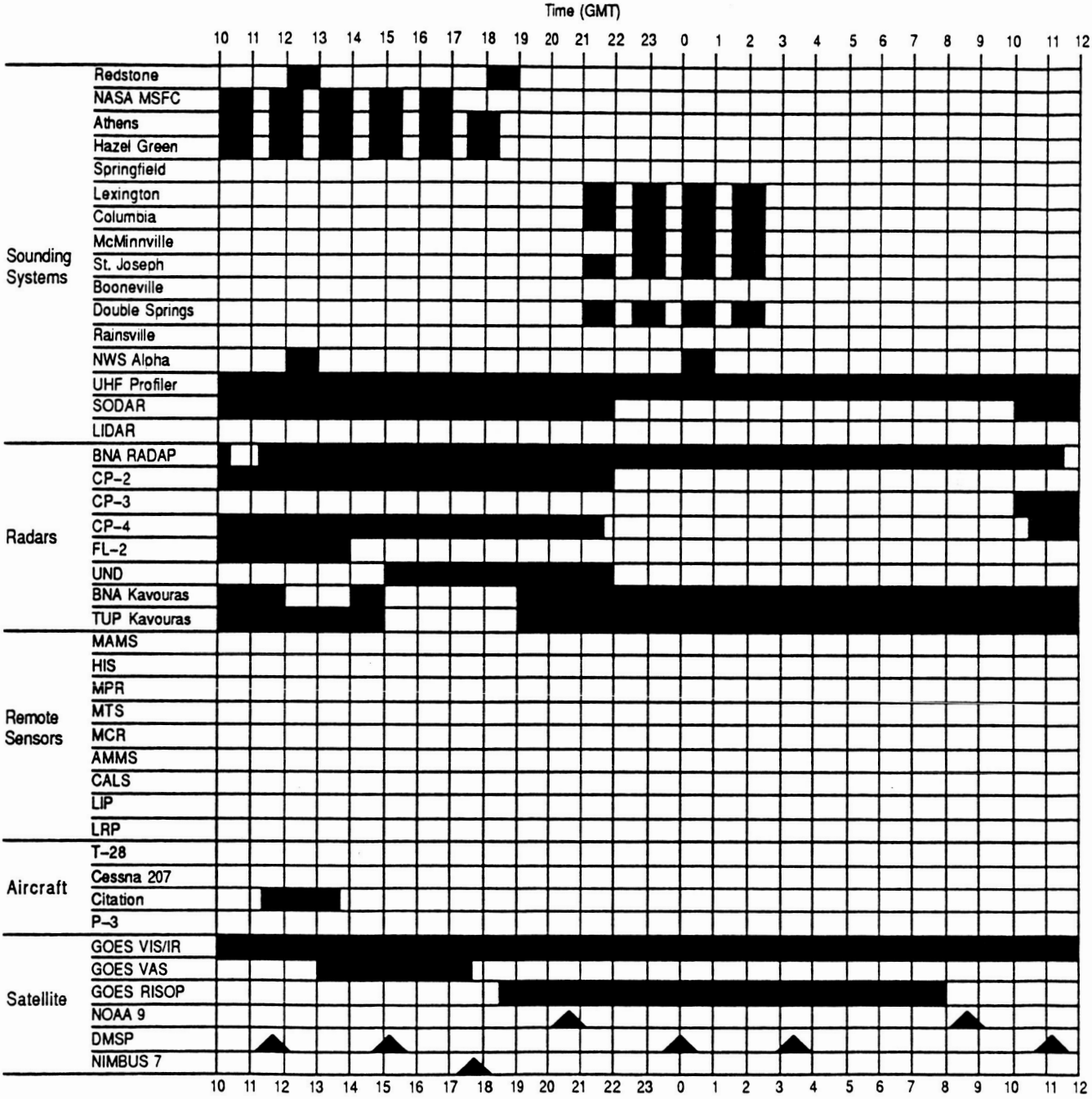
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5-550-7-8(58)

Day: TUESDAY
Date: 7/29/86
Julian Day: 210–211

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATION 5
	TVA ADAS	MISSING STATIONS 30, 52, 59, 62
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

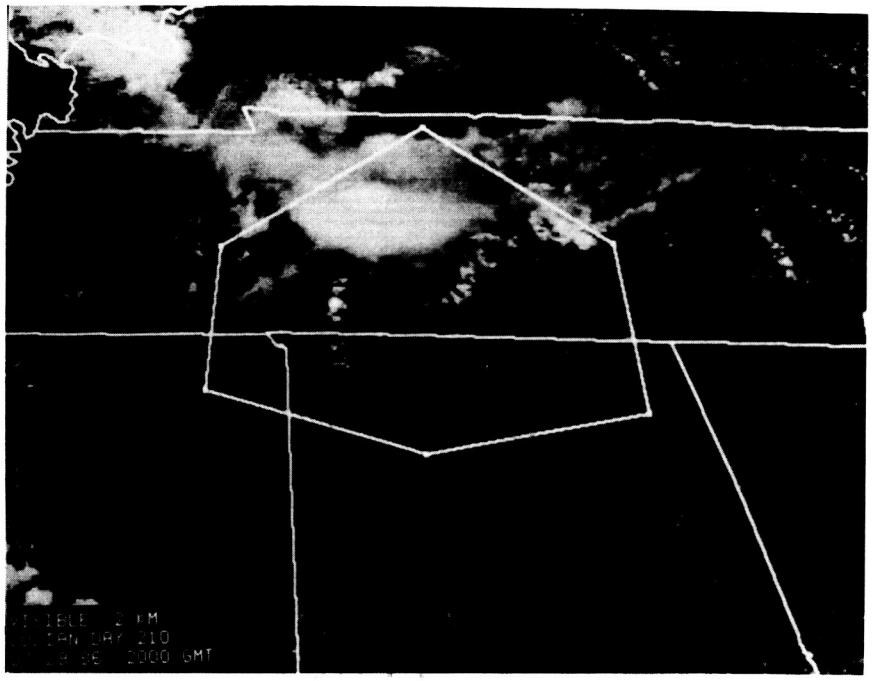


Fig. 3.2-58b. Visible 2 km GOES Central satellite image for 29 July 1986 2000 GMT

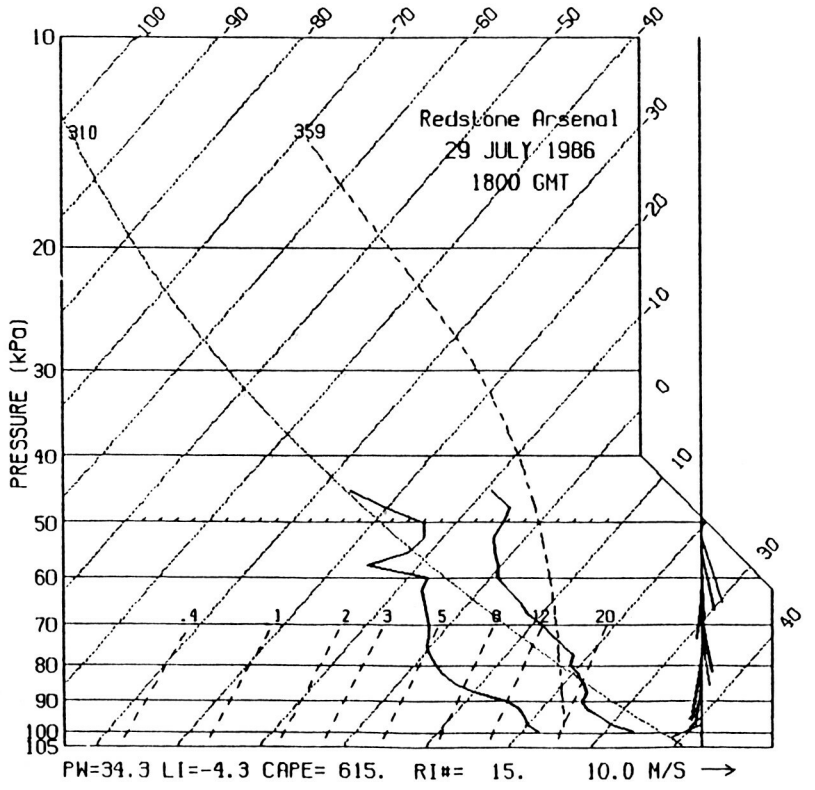


Fig. 3.2-58c. Redstone Arsenal, AL, rawinsonde sounding for 29 July 1986 1800 GMT

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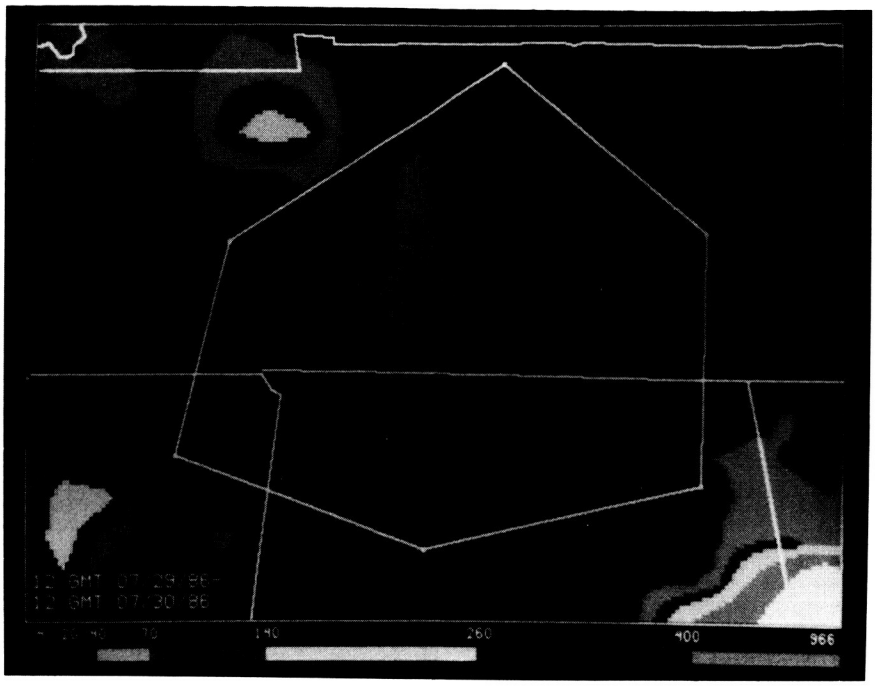


Fig. 3.2-58d. Twenty-four hour lightning strike density plot for 29-30 July 1986

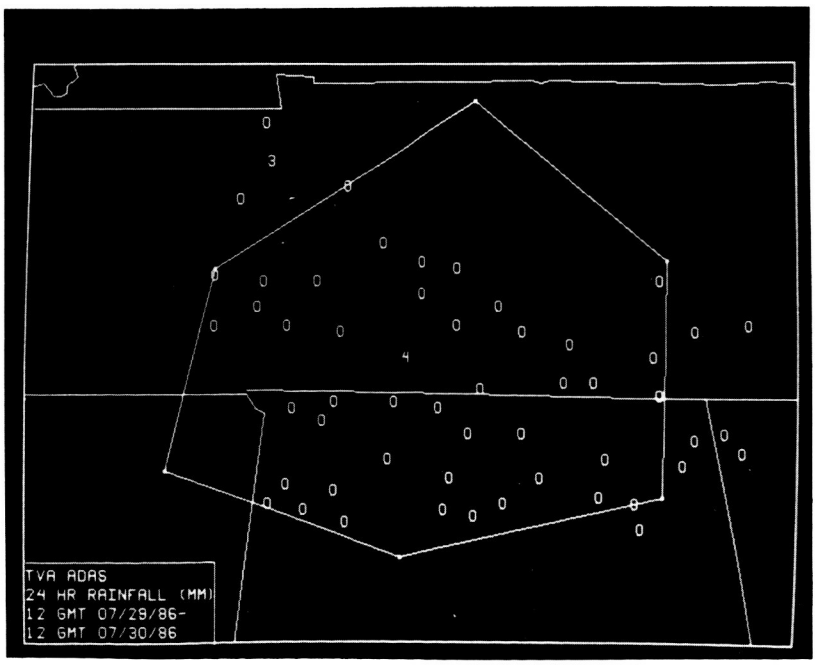


Fig. 3.2-58e. Twenty-four hour TVA ADAS rainfall totals (mm) for 29-30 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

30 July 1986

Synoptic Conditions

Northwesterly flow continued to prevail over the SPACE mesonet. The cold front that entered the mesonet yesterday had moved entirely through the mesonet by 1800 GMT today. The air was drier, but generally warm temperatures remained. Surface temperature and dewpoint values over the mesonet varied from 35 and 16 °C over the north to 37 and 18 °C over the south.

Cloud/Precipitation Overview

This was a hot and dry day with very little potential instability. Sky conditions over the SPACE network were mostly clear, and no precipitation was reported. Significant thunderstorm activity in the form of a well defined MCS was prominent over southern Alabama and southeastern Mississippi.

Notes:

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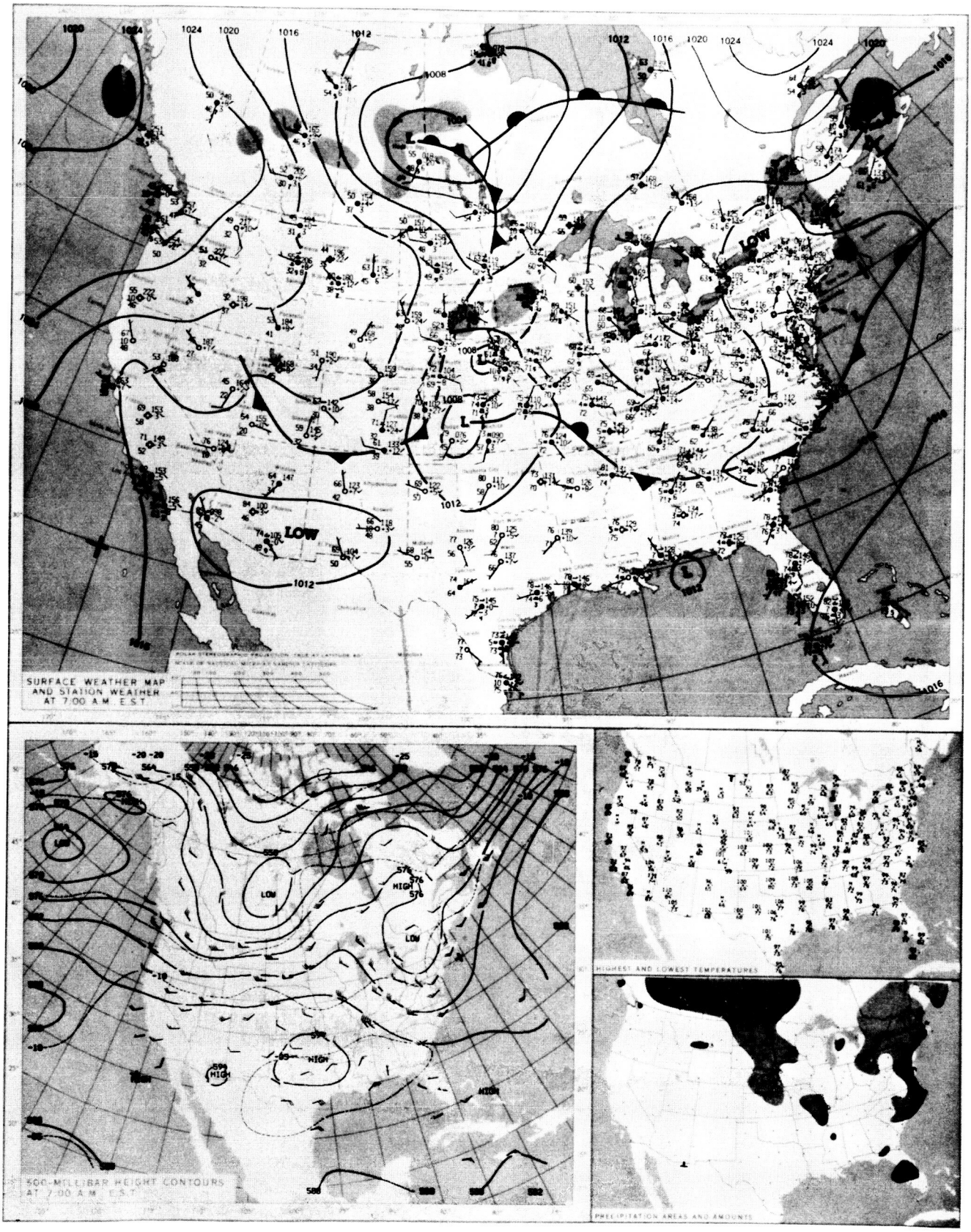


Fig. 3.2-59a. Synoptic weather conditions for 30 July 1986 1200 GMT

OPERATIONAL SUMMARY

30 July 1986

Rawinsonde Operations

The default 1200 and 1800 GMT RSA soundings were made.

Radar Operations

CP-3 and CP-4 were activated near dawn to conduct a bird study. All afternoon precipitation echoes were out of range far to the south.

Satellite Operations

GOES VAS products were archived from 1230 to 1730 GMT. RISOP was started at 1930 GMT, but will be of little value.

Aircraft Operations

No operations.

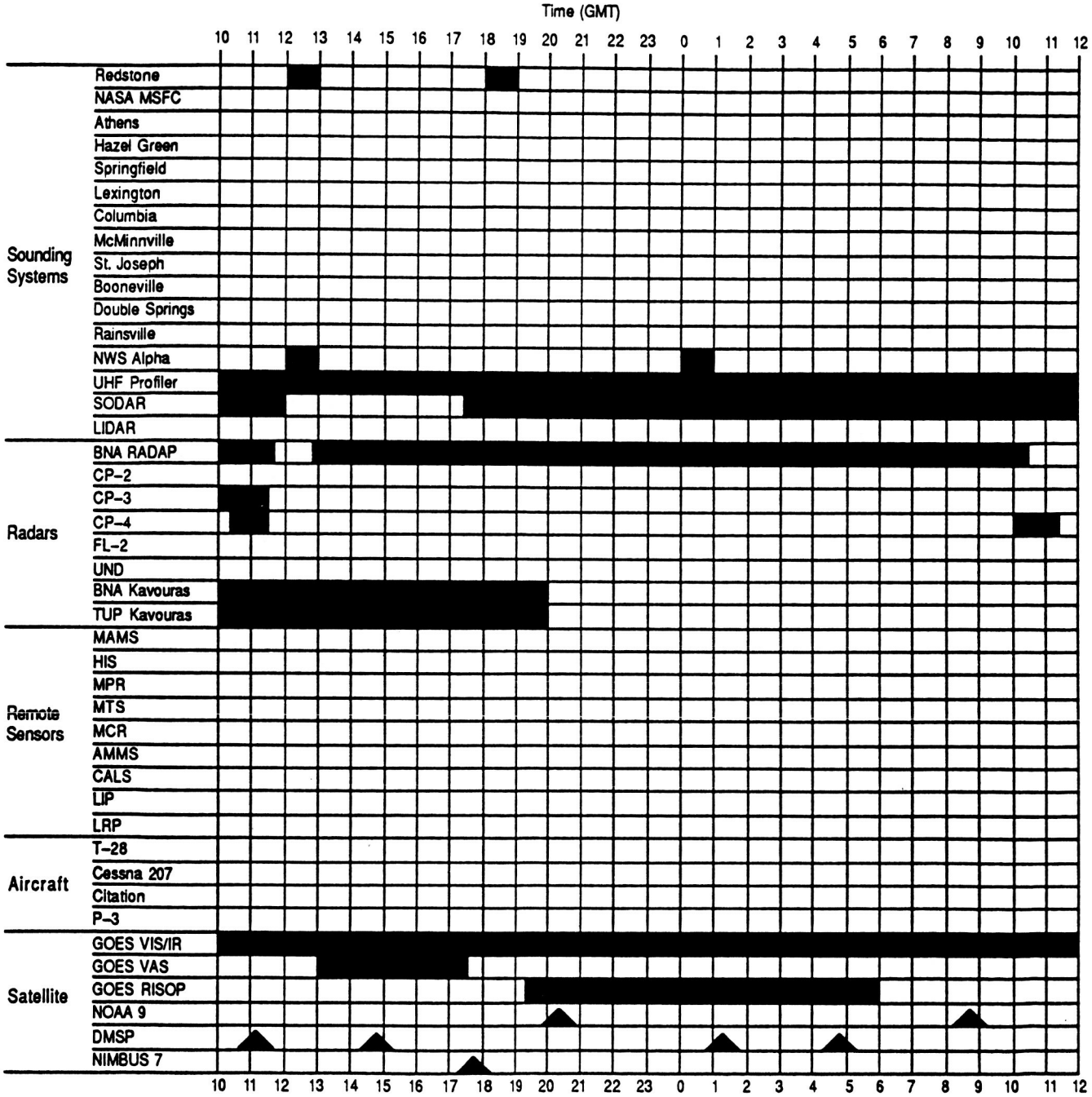
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5-550-7-8(59)

Day: WEDNESDAY
Date: 7/30/86
Julian Day: 211-212

Hourly Collection of COHMEX Data



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 21, 27, 30, 52, 59 & 62
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

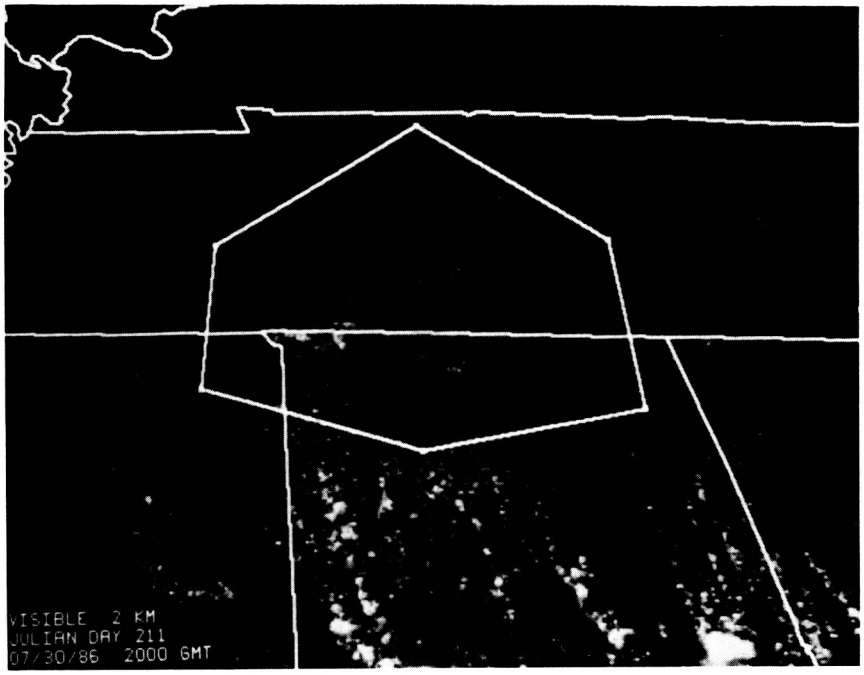


Fig. 3.2-59b. Visible 2 km GOES Central satellite image for 30 July 1986 2000 GMT

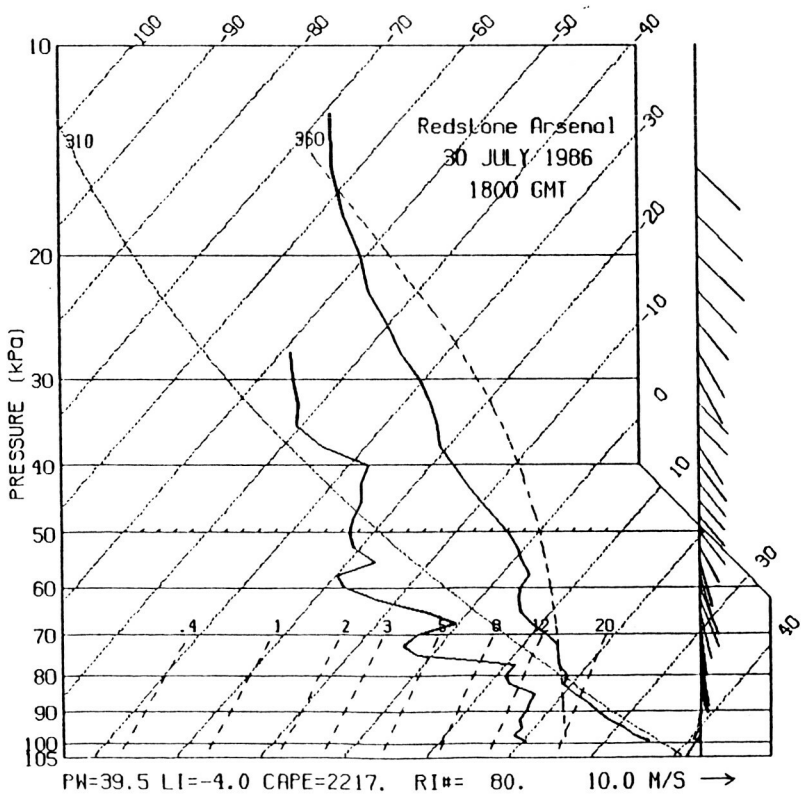


Fig. 3.2-59c. Redstone Arsenal, AL, rawinsonde sounding for 30 July 1986 1800 GMT

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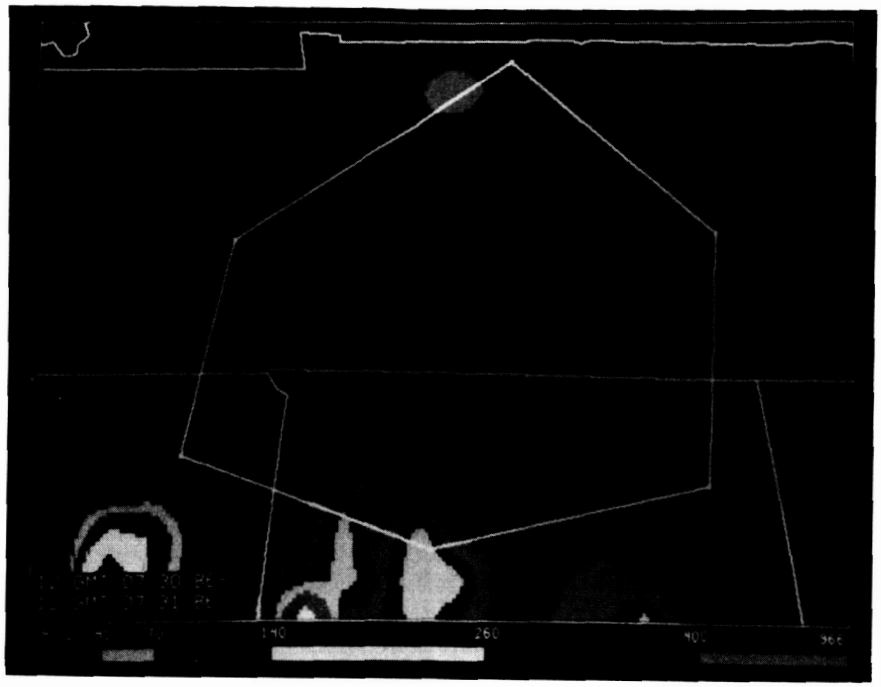


Fig. 3.2-59d. Twenty-four hour lightning strike density plot for 30-31 July 1986

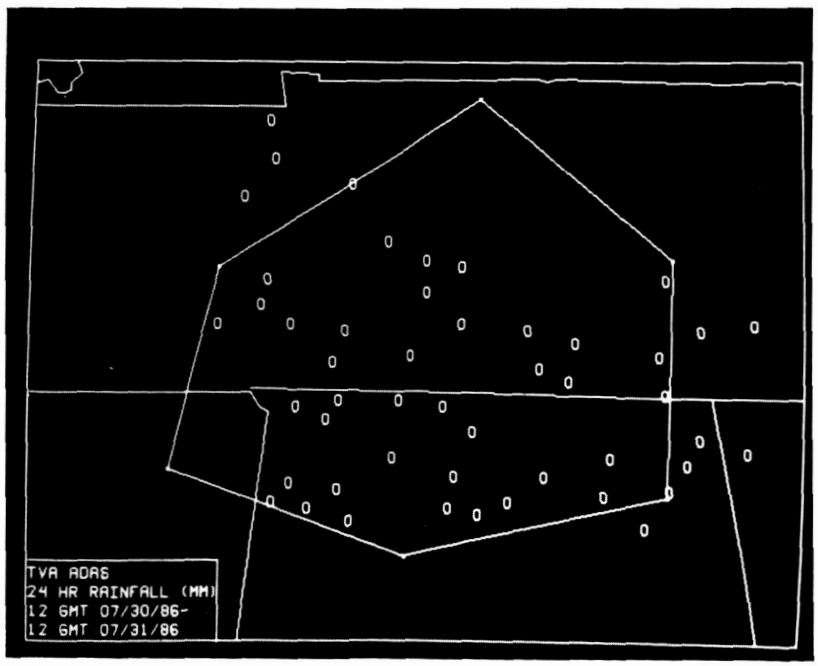


Fig. 3.2-59e. Twenty-four hour TVA ADAS rainfall totals (mm) for 30-31 July 1986

SYNOPTIC AND PRECIPITATION OVERVIEW

31 July 1986

Synoptic Conditions

A very weak stationary front oriented northwest to southeast was analyzed over the SPACE mesonet during the daytime hours. Winds aloft over the region remained northwesterly at 5-15 m s^{-1}, but the ridge centered over Texas on previous days decreased in amplitude by 1200 GMT today. The 1800 GMT RSA sounding had destabilized from yesterday as lower levels warmed and middle levels cooled. Thunderstorms were expected to develop along a large scale outflow boundary produced by a large, dissipating MCS which passed just north of the SPACE mesonet during the morning hours. This boundary eventually moved over the entire network by midafternoon. Afternoon surface temperature and dewpoint values over the SPACE mesonet were quite variable because of this and other outflow boundaries. Over the southwestern mesonet, values of 38 and 20 °C were recorded. Surface winds were generally convergent, being easterly at 4-6 m s^{-1} over the eastern mesonet (within the cool outflow air) and westerly at 2-4 m s^{-1} over the hot western portion of the mesonet.

Cloud/Precipitation Overview

This was a very active MCS day within and around the region, with three MCSs affecting the SPACE mesonet. A very large MCS grazed the northeastern corner of the network during early morning hours, pushing a large outflow boundary through the network. A second MCS formed near 1700 GMT along this boundary over the central SPACE mesonet, intensifying and consolidating over the southeastern portion of the network. Storms within this system were intense and severe, producing microbursts with damaging winds, hailstones up to 6 cm in diameter, and copious amounts of lightning. Outflow winds were in general very strong. The gust front associated with the developing system over the MIST/FLOWS network quickly outran the existing convection and triggered only scattered activity thereafter. FL-2 personnel logged 14 microbursts over and adjacent to the MIST/FLOWS mesonet and noted that these events lasted longer than average. A maximum velocity differential of 36 m s^{-1} over 4.4 km was measured.

Yet a third MCS was initiated near 0100 GMT (Aug. 1), again over the central SPACE mesonet. This system also produced microbursts and frequent lightning as it consolidated and moved east-northeast out of the mesonet. A final (fourth) MCS formed outside the beta network over southeastern Missouri and northeastern Mississippi. All MCSs exhibited circular shapes and produced copious amounts of lightning.

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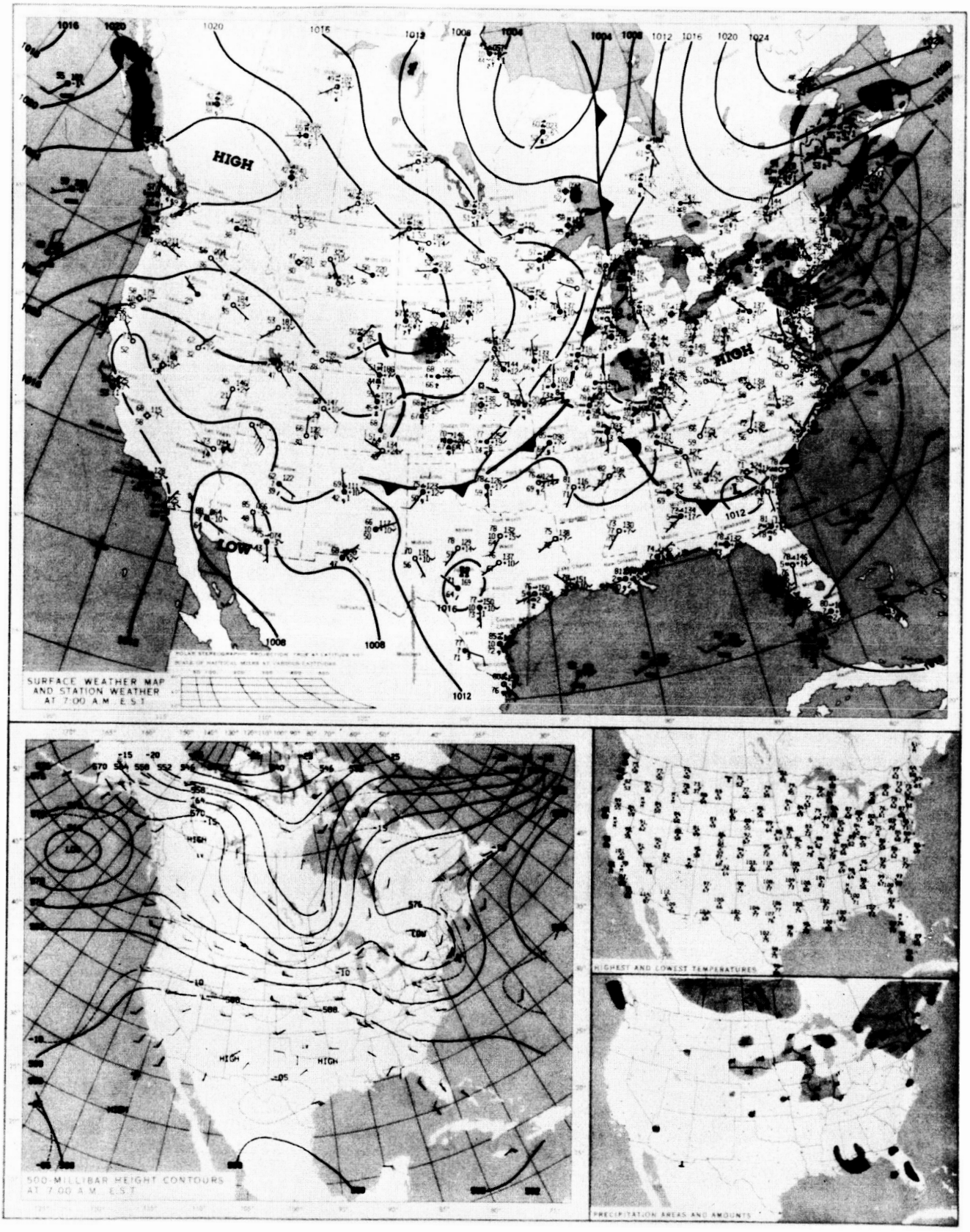


Fig. 3.2-60a. Synoptic weather conditions for 31 July 1986 1200 GMT

OPERATIONAL SUMMARY

31 July 1986

Rawinsonde Operations

A Meso-beta rawinsonde operation was conducted from 1800 GMT to 0300 GMT. Unfortunately, sounding coverage in the development MCS region was absent because the southeastern most station (Rainsville) was down.

Radar Operations

The Doppler radars conducted miscellaneous scans on individual storms within the developing MCS (number 2). There should be some good multiple Doppler scans on individual intense cells. Radar coverage of this system appears to be virtually complete. However, radar coverage on the evening MCS is only partial.

Satellite Operations

GOES VAS products were archived through 1630 GMT. This data set should be complete enough to portray features associated with the development of intense convection at about 1700 GMT. RISOP which started at 1830 GMT should cover the developing to mature stages of development of intense convection that moved over the MIST/FLOWS network.

Aircraft Operations

The Cessna 207 and Citation made numerous penetrations through the outflow boundaries of a MCS (system number 2) developing north of and over the MIST/FLOWS gamma network. Vertical motions and turbulence along the gust front were quite large. This will produce an excellent data set when combined with Doppler radar data. In addition, the Citation accomplished boxes around some intense cells at middle levels.

Notes:

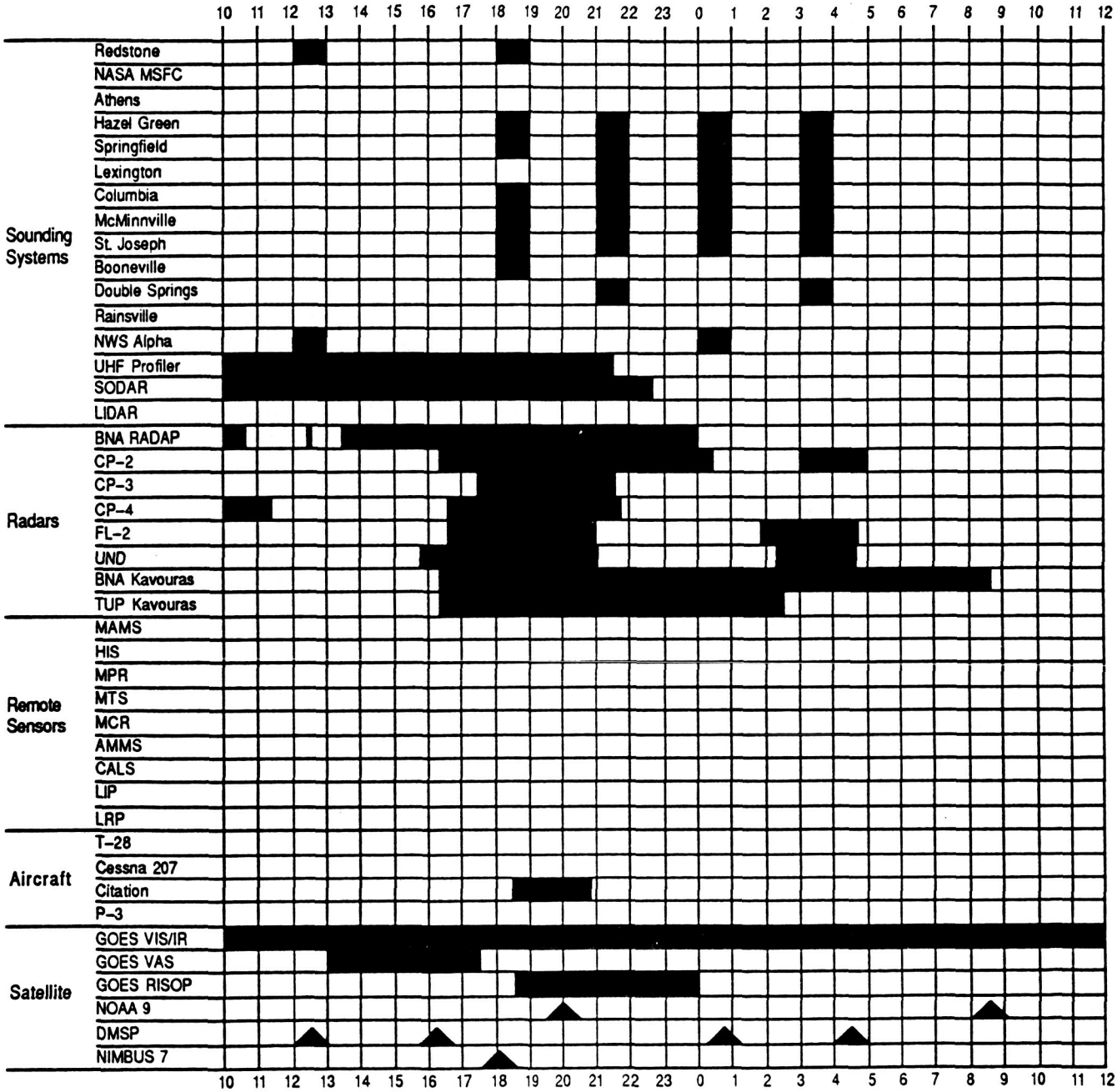
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5-550-7-8(60)

Day: THURSDAY
Date: 7/31/86
Julian Day: 212-213

Hourly Collection of COHMEX Data

Time (GMT)



Comments

Surface Systems	PAM	OPERATIONAL
	FAM	OPERATIONAL
	NAM	MISSING STATIONS 4 & 5
	TVA ADAS	MISSING STATIONS 21, 45 & 54
	LLP	OPERATIONAL
	Mobile Lab	NOT OPERATIONAL

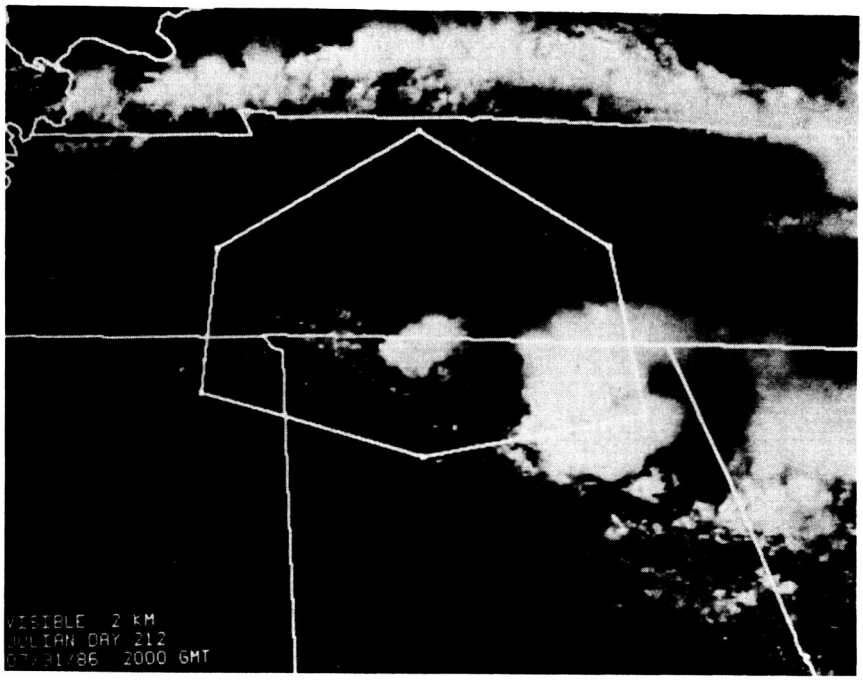


Fig. 3.2-60b. Visible 2 km GOES Central satellite image for 31 July 1986 2000 GMT

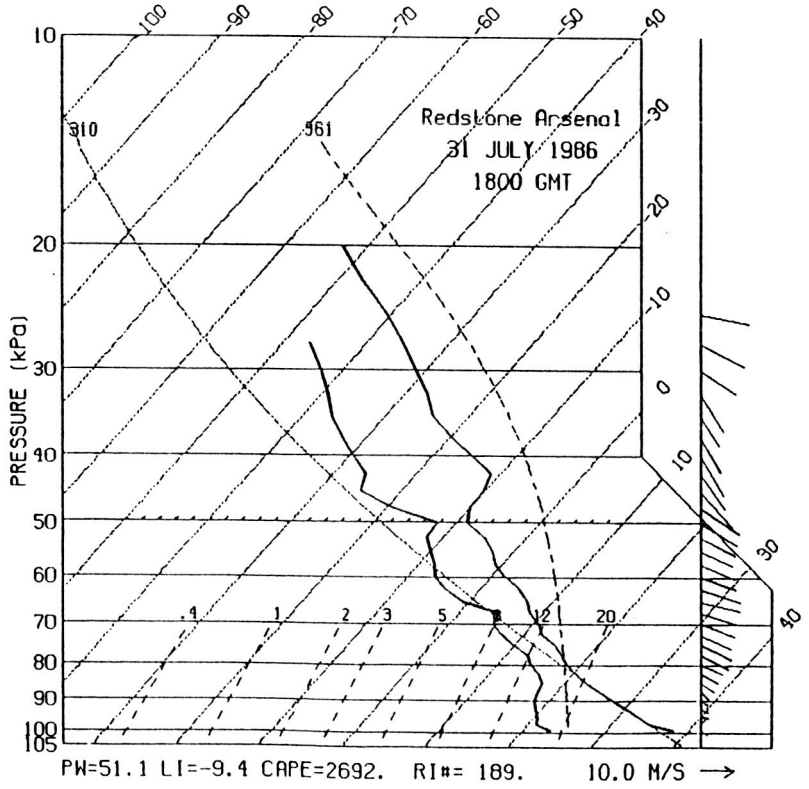


Fig. 3.2-60c. Redstone Arsenal, AL, rawinsonde sounding for 31 July 1986 1800 GMT

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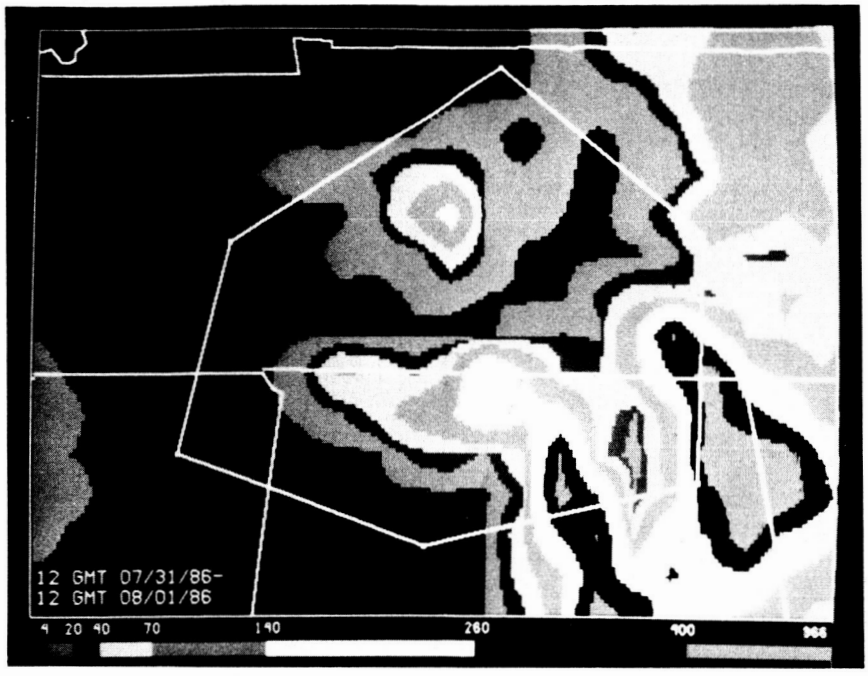


Fig. 3.2-60d. Twenty-four hour lightning strike density plot for 31 July - 1 August 1986

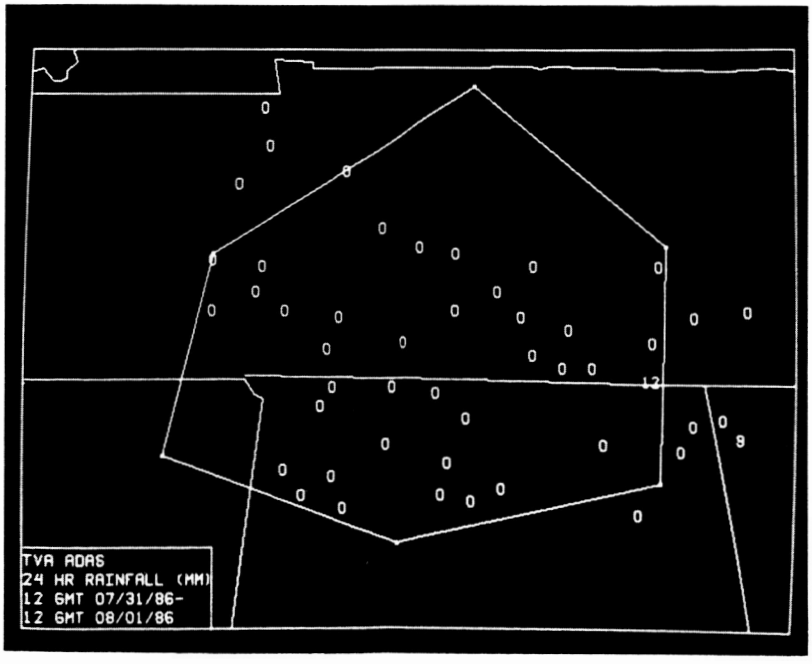


Fig. 3.2-60e. Twenty-four hour TVA ADAS rainfall totals (mm) for 31 July - 1 August 1986

APPENDIX A

U-2C / ER-2 FLIGHT TRACKS

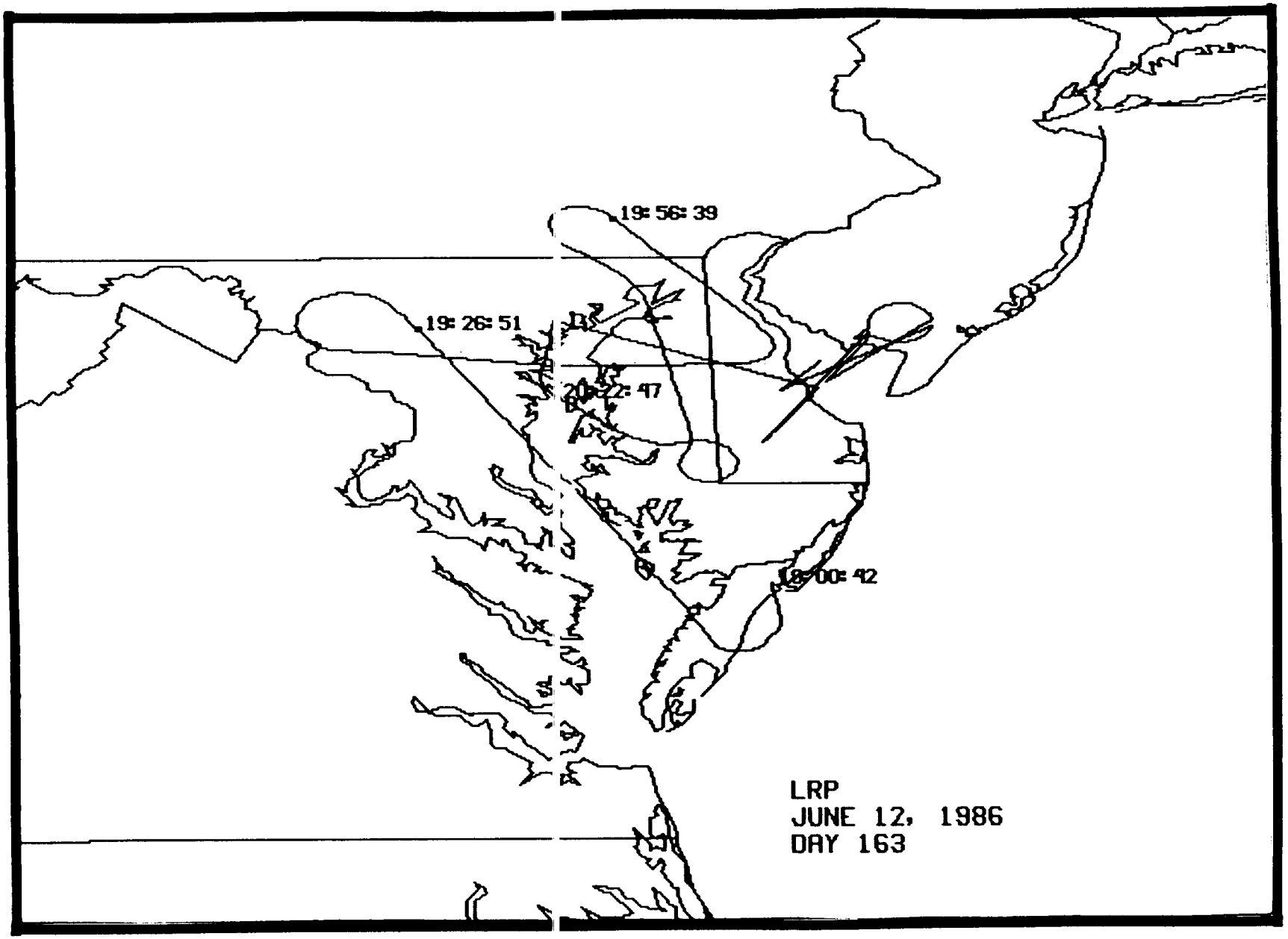
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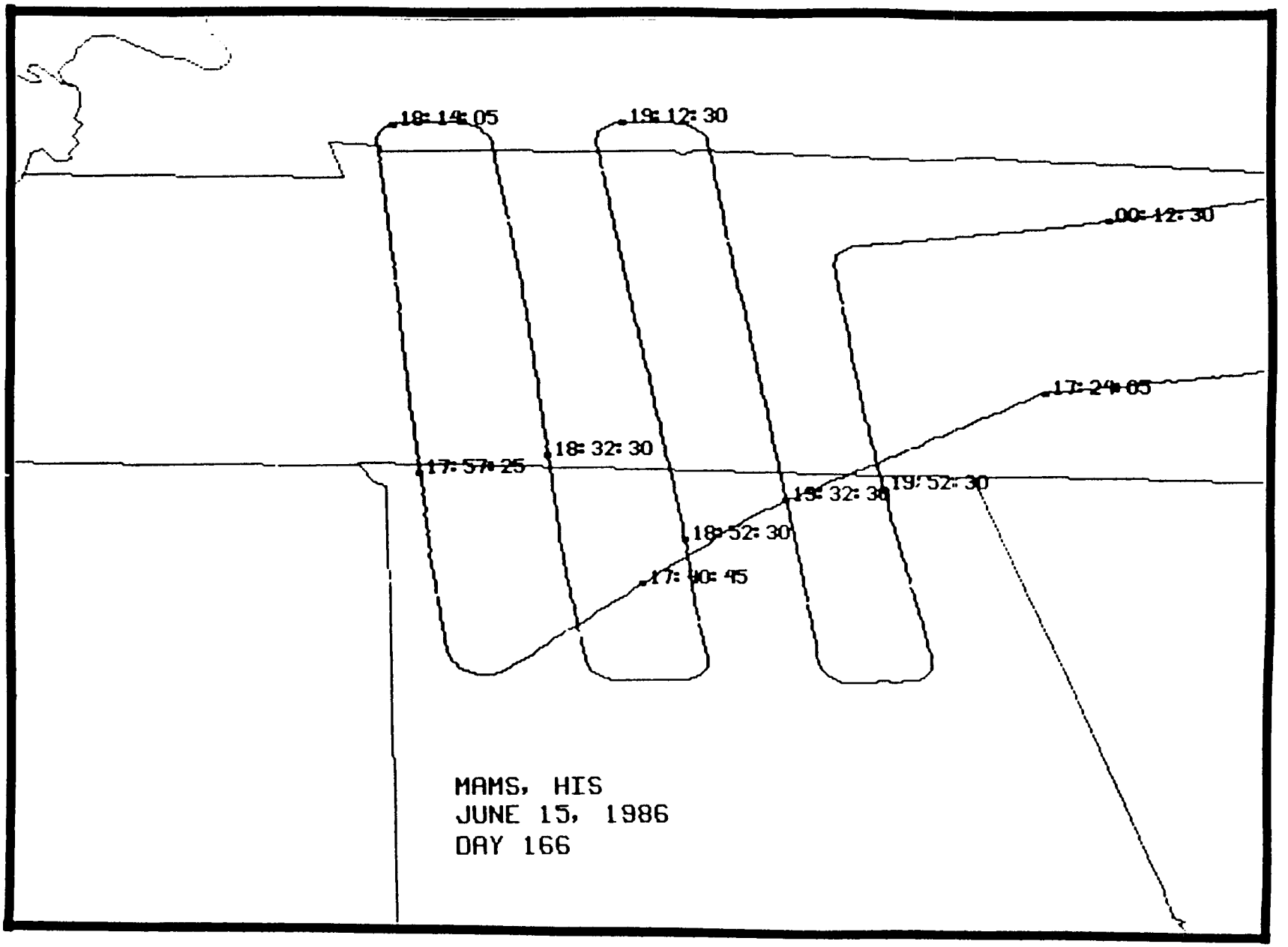
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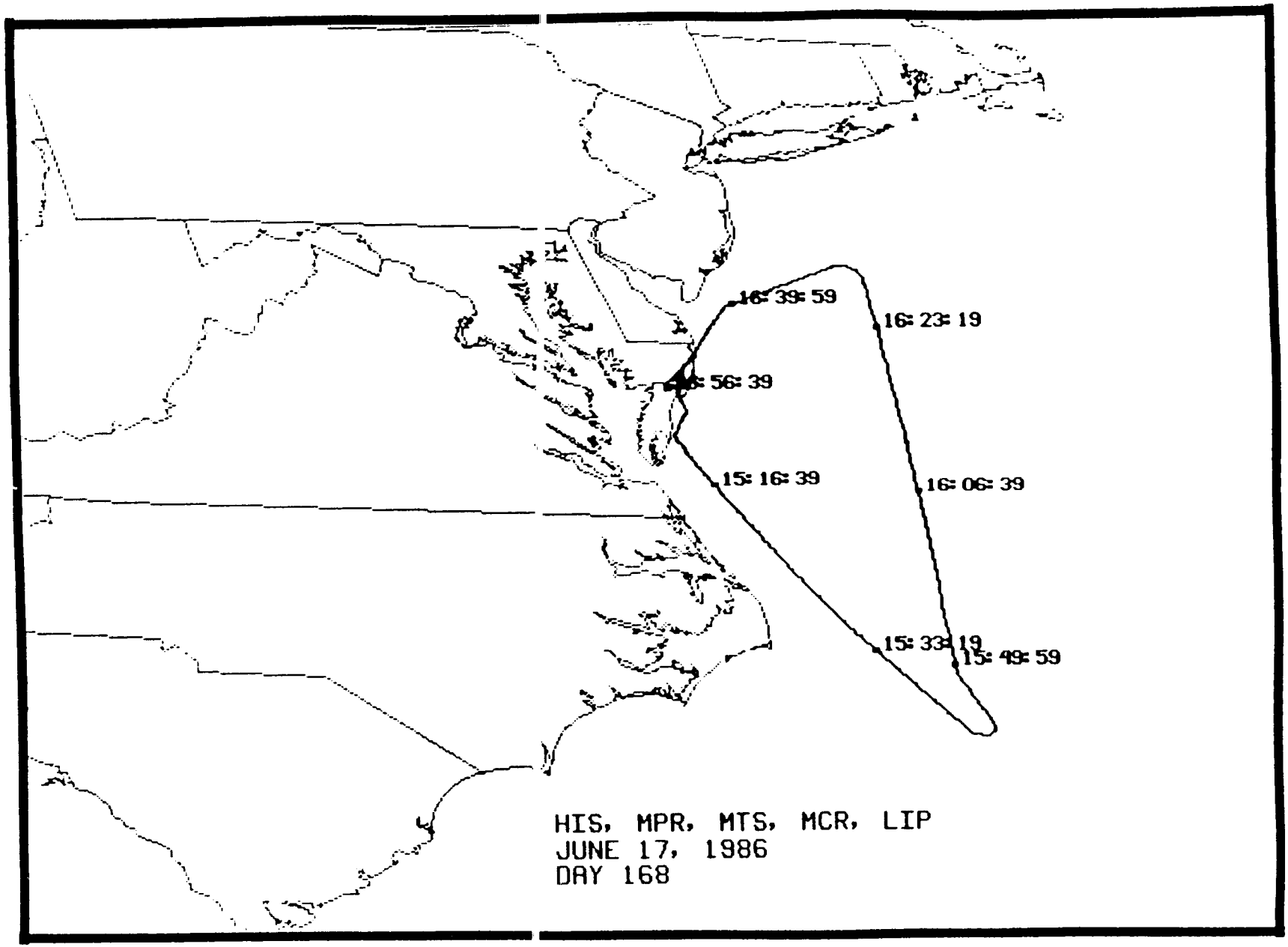
APPENDIX A

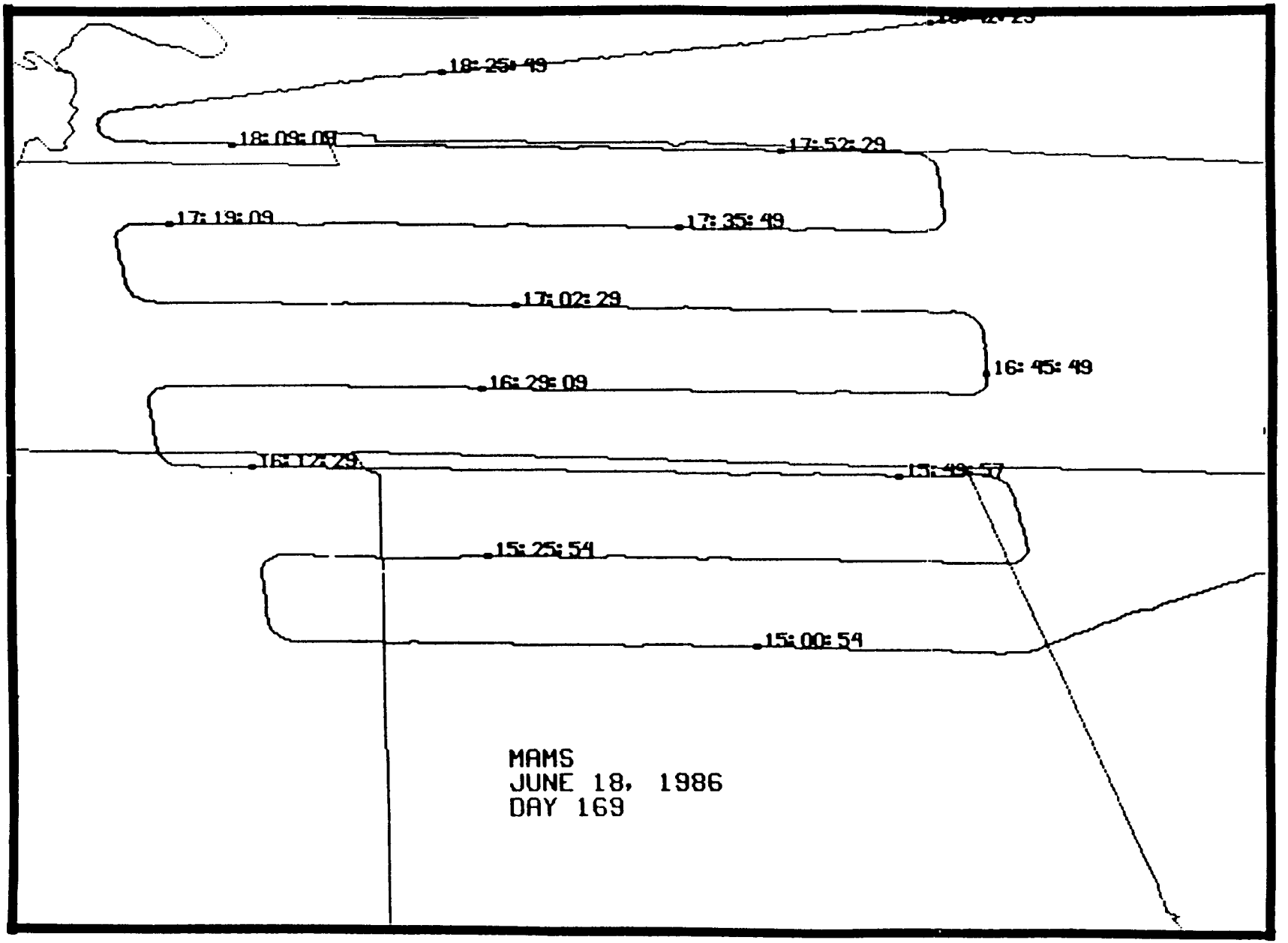
Table A-1. Operation Times of SPANDAR Radar During ER-2/U2-C Overflights

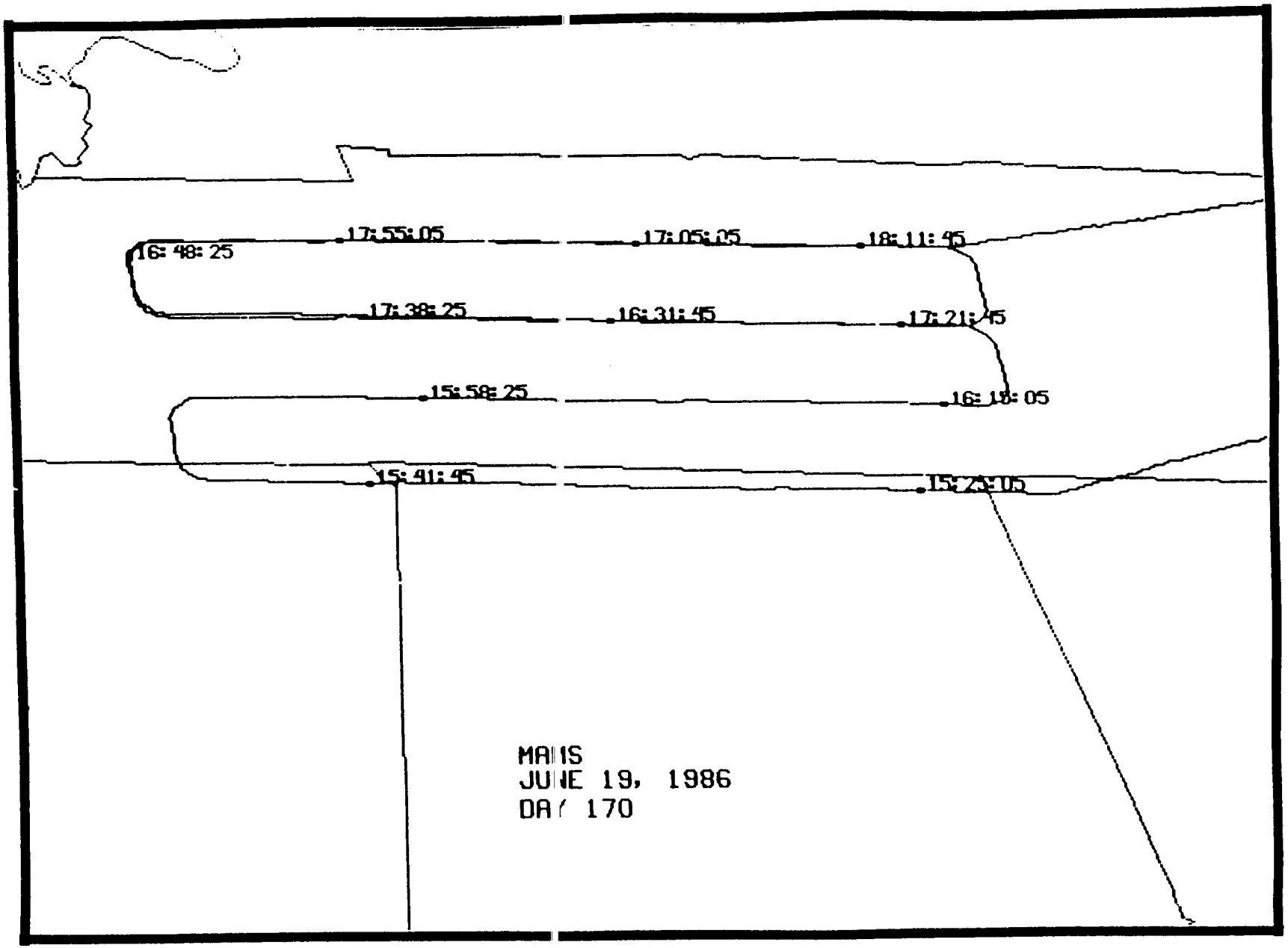
Date	Time (GMT)	Aircraft
12 June 1986	1853 - 2305	U2-C
20 June 1986	1405 - 1824	ER-2
29 June 1986	1849 - 0055	U2-C
1 July 1986	1518 - 1940	ER-2
9 July 1986	2030 - 2335	ER-2

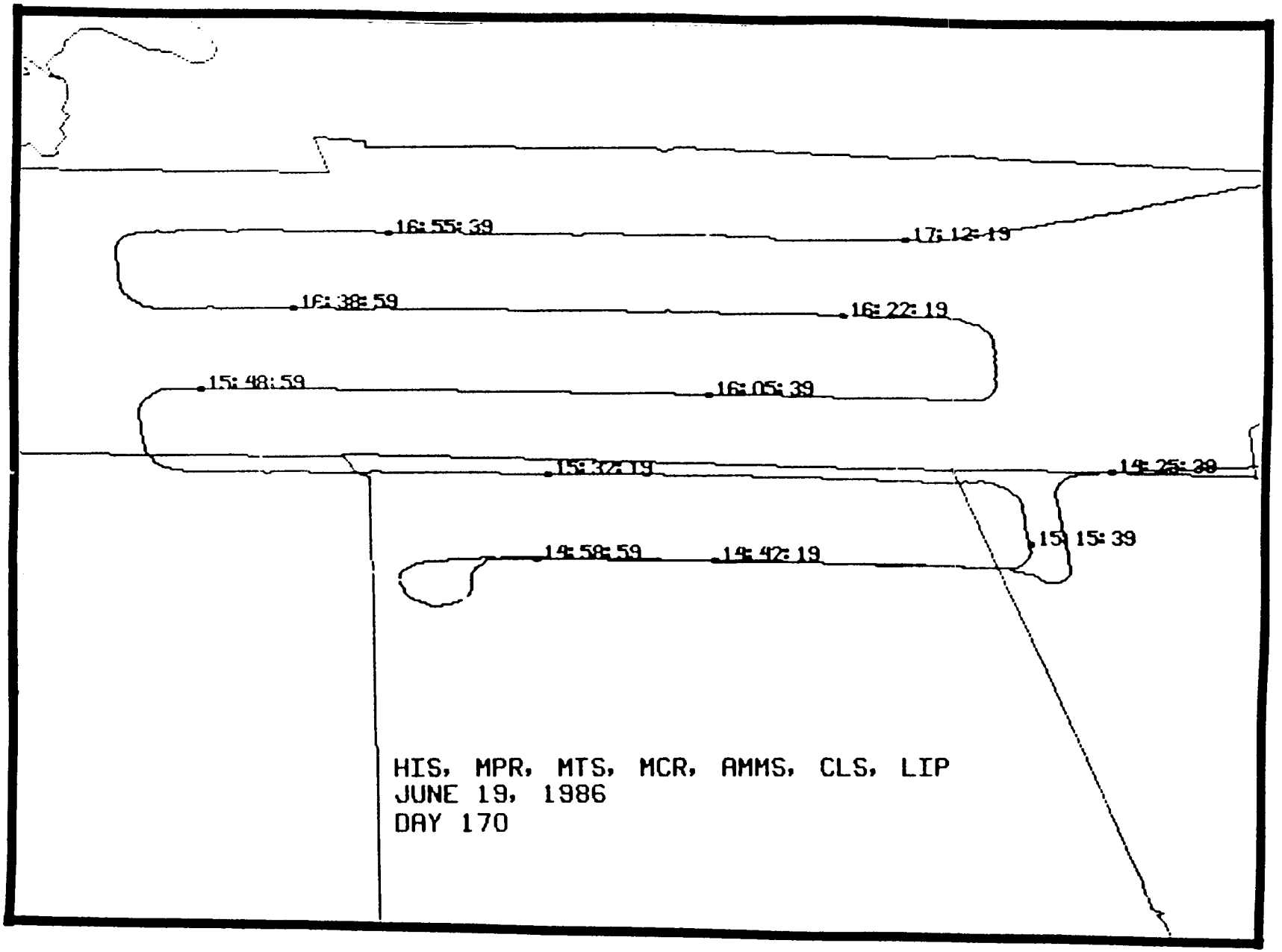

19: 56: 39
19: 26: 51
20: 00: 42
LRP
JUNE 12, 1986
DAY 163

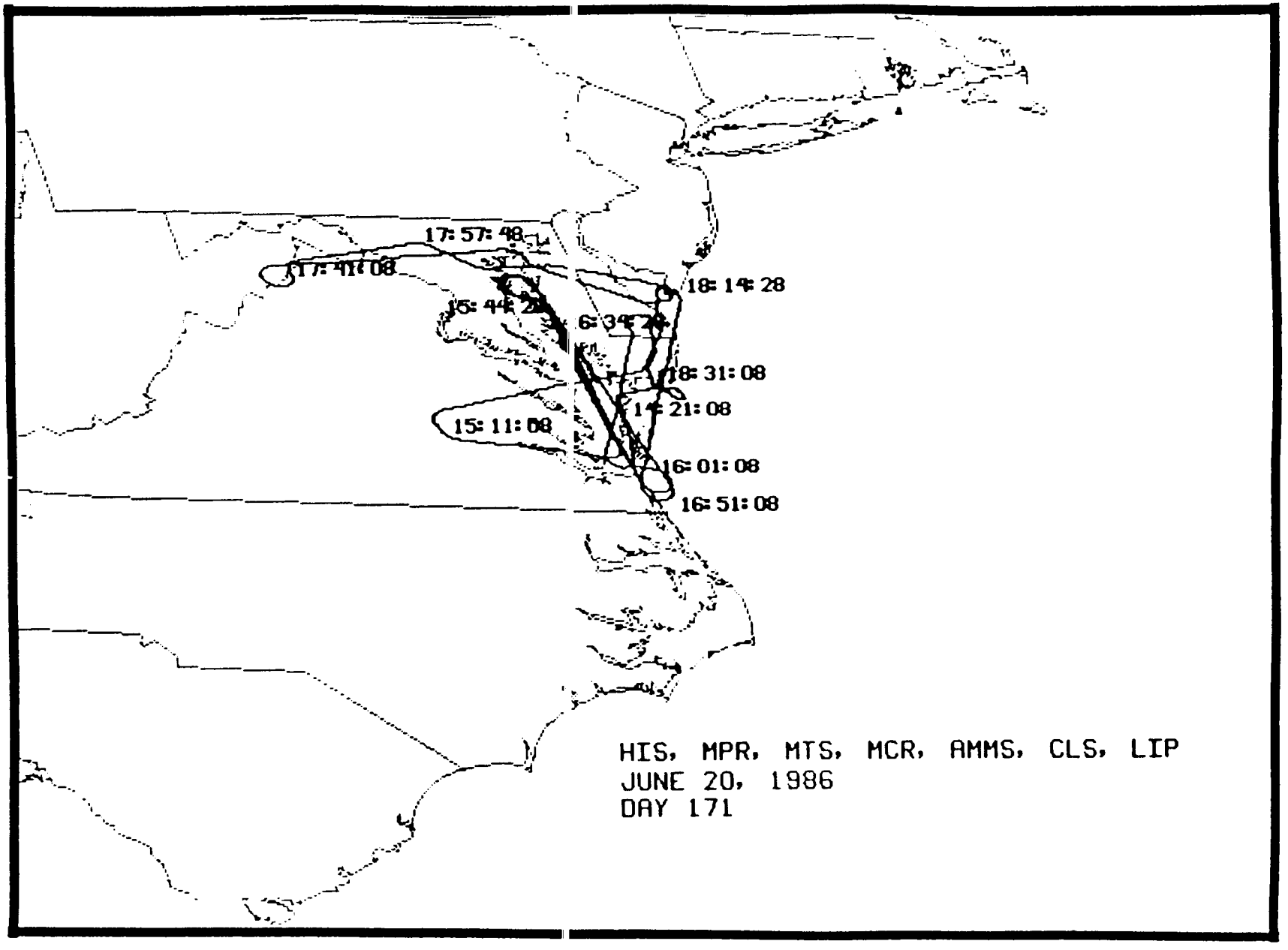

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19:12:30
00:12:30
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17:57:25
18:32:30
19:52:30
18:52:30
MAMS, HIS
JUNE 15, 1986
DAY 166

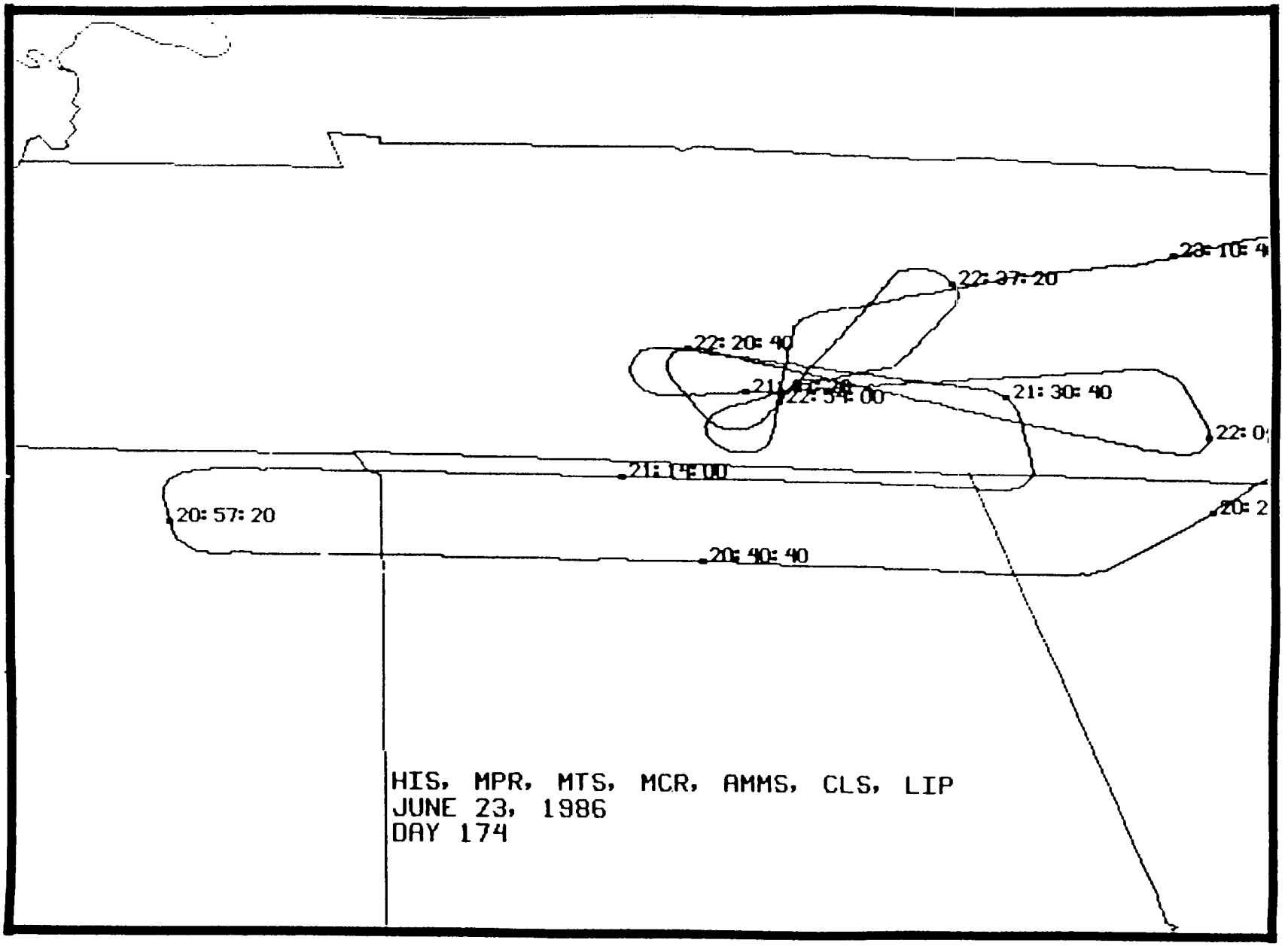

16: 39: 59
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15: 33: 19
15: 49: 59
HIS, MPR, MTS, MCR, LIP
JUNE 17, 1986
DAY 168

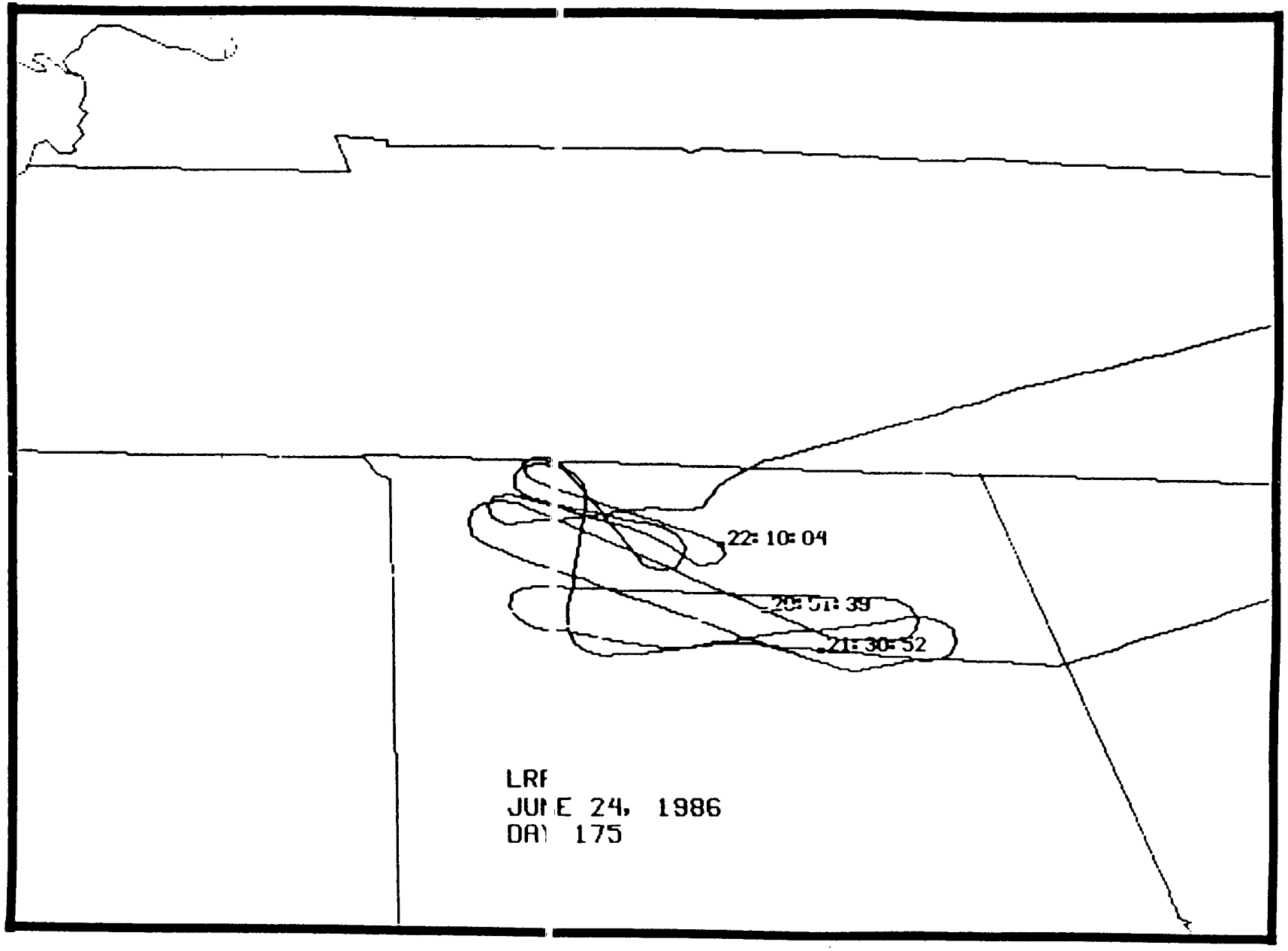

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17:02:29
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15:49:57
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15:00:54
MAMS
JUNE 18, 1986
DAY 169

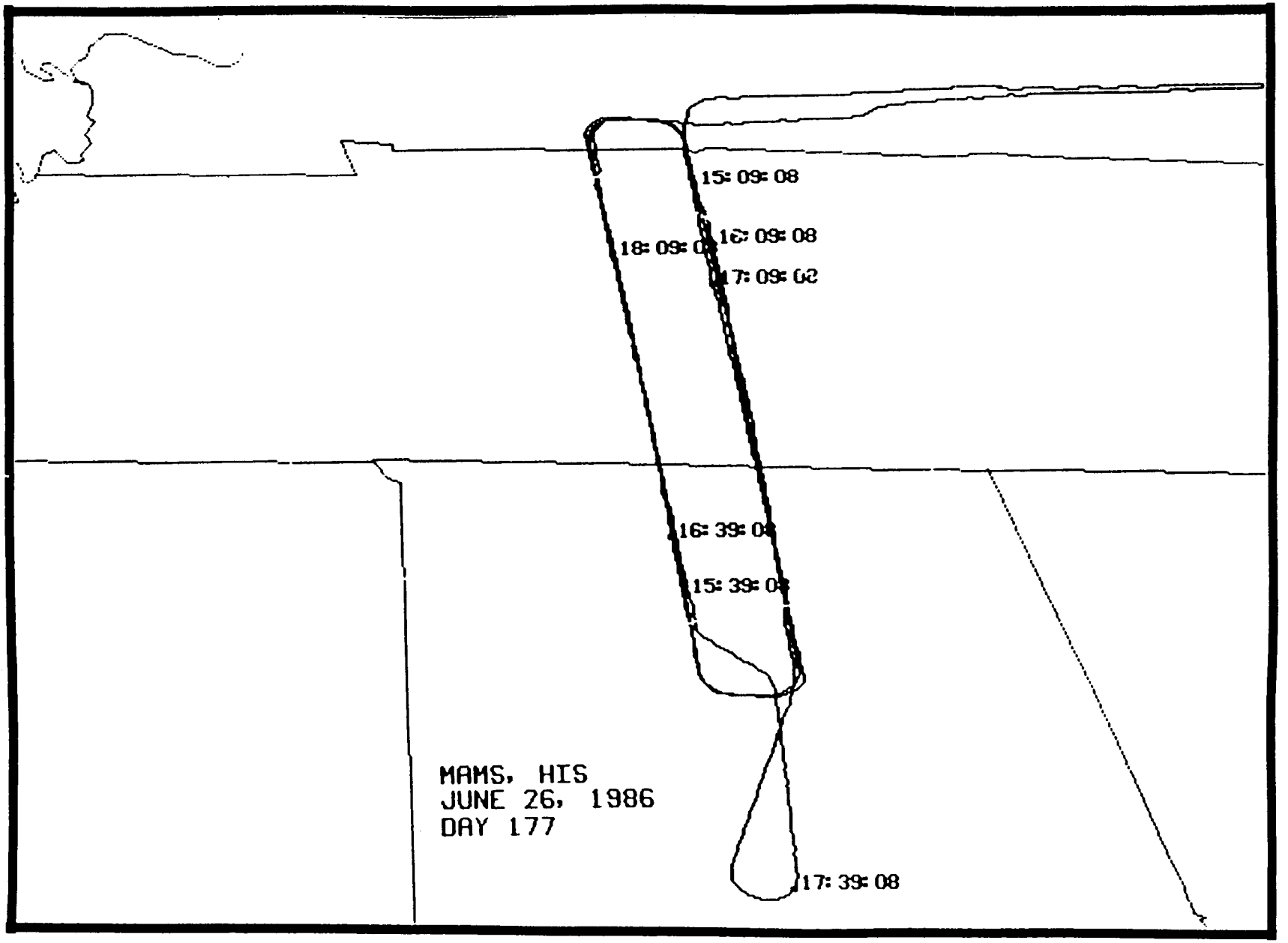

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15:25:05
MAIS
JUNE 19, 1986
DAY 170

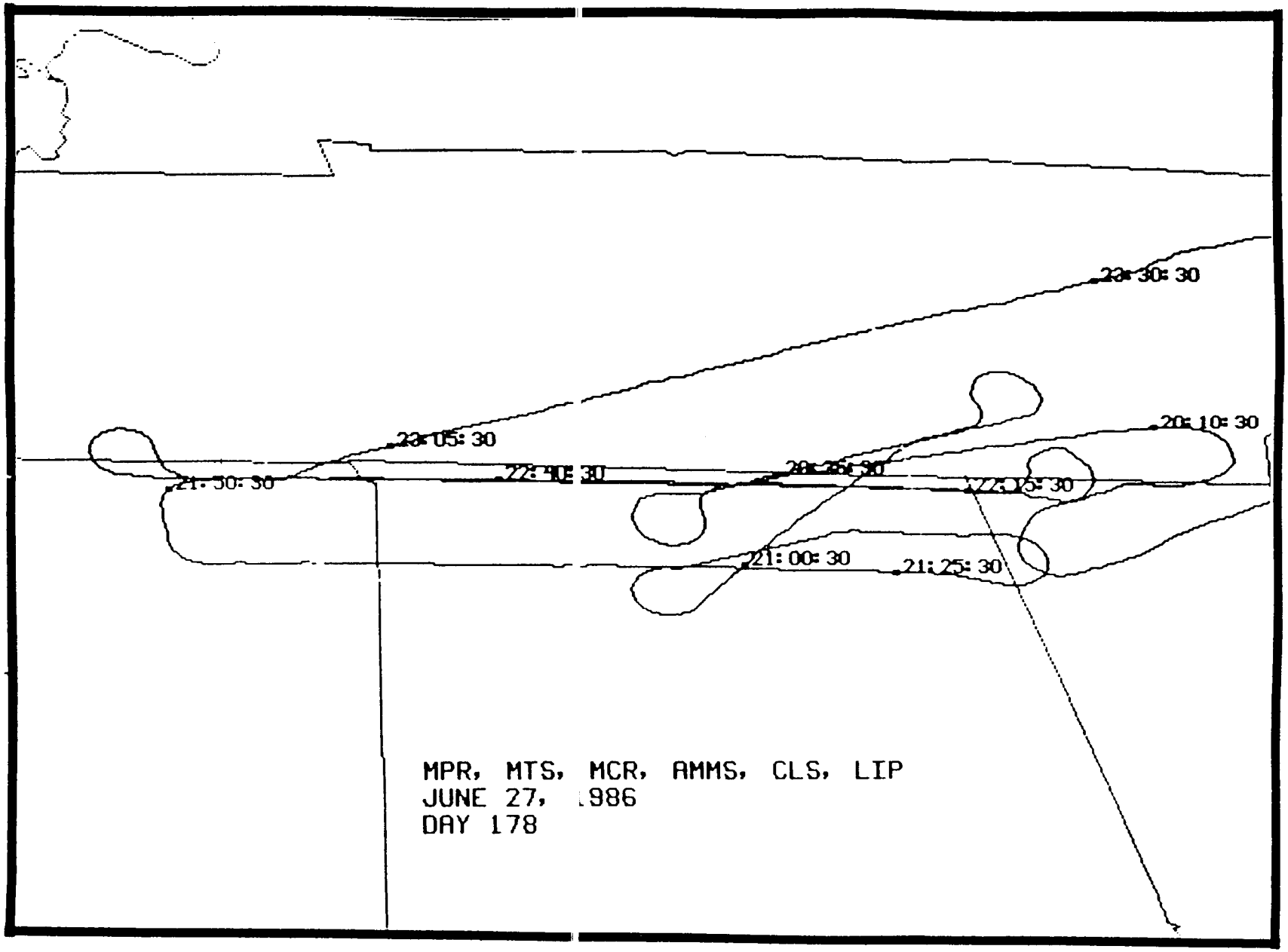

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14:58:59
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HIS, MPR, MTS, MCR, AMMS, CLS, LIP
JUNE 19, 1986
DAY 170

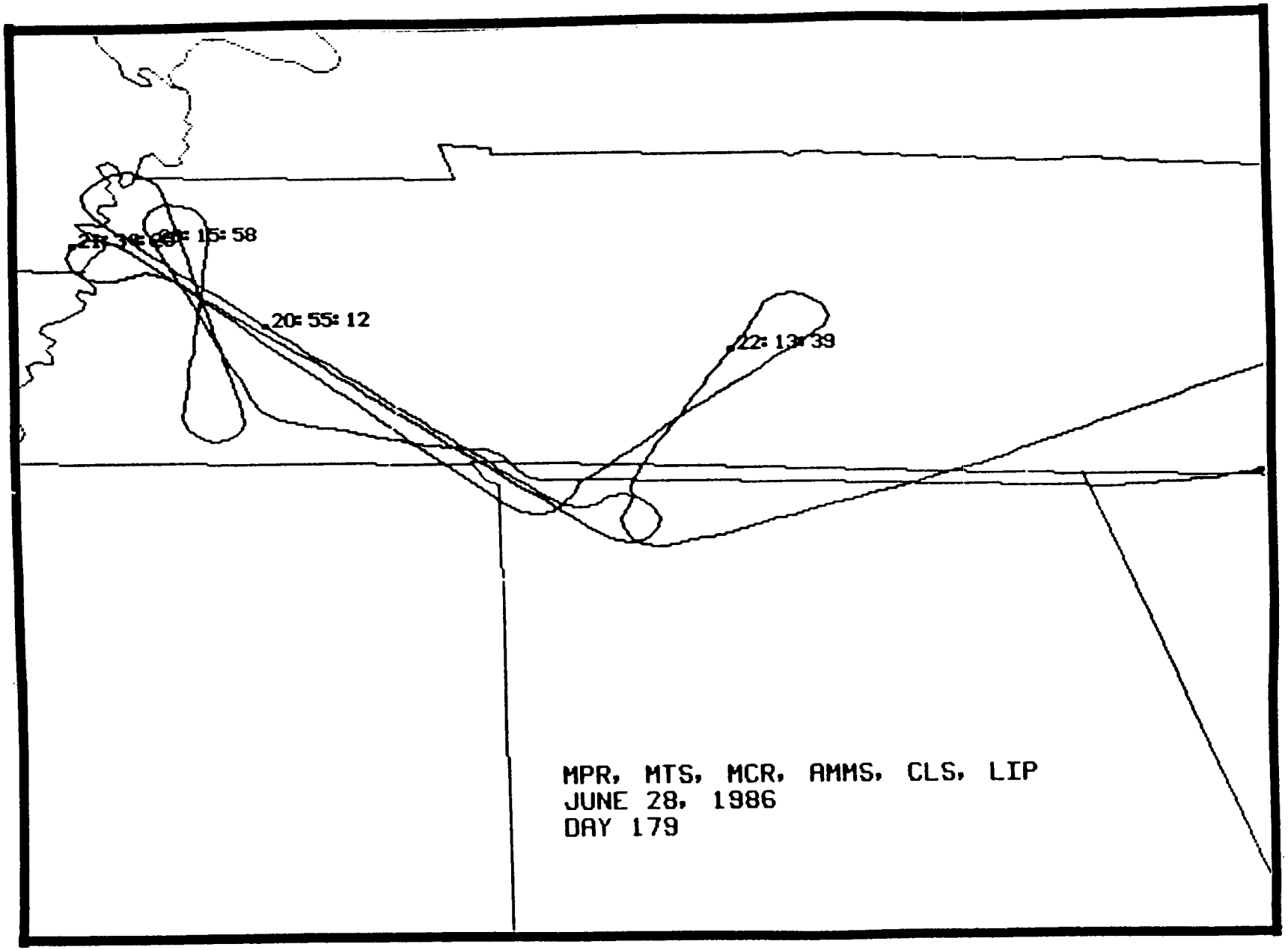

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18: 14: 28
16: 44: 28
16: 34: 28
18: 31: 08
14: 21: 08
15: 11: 08
16: 01: 08
16: 51: 08
HIS, MPR, MTS, MCR, AMMS, CLS, LIP
JUNE 20, 1986
DAY 171

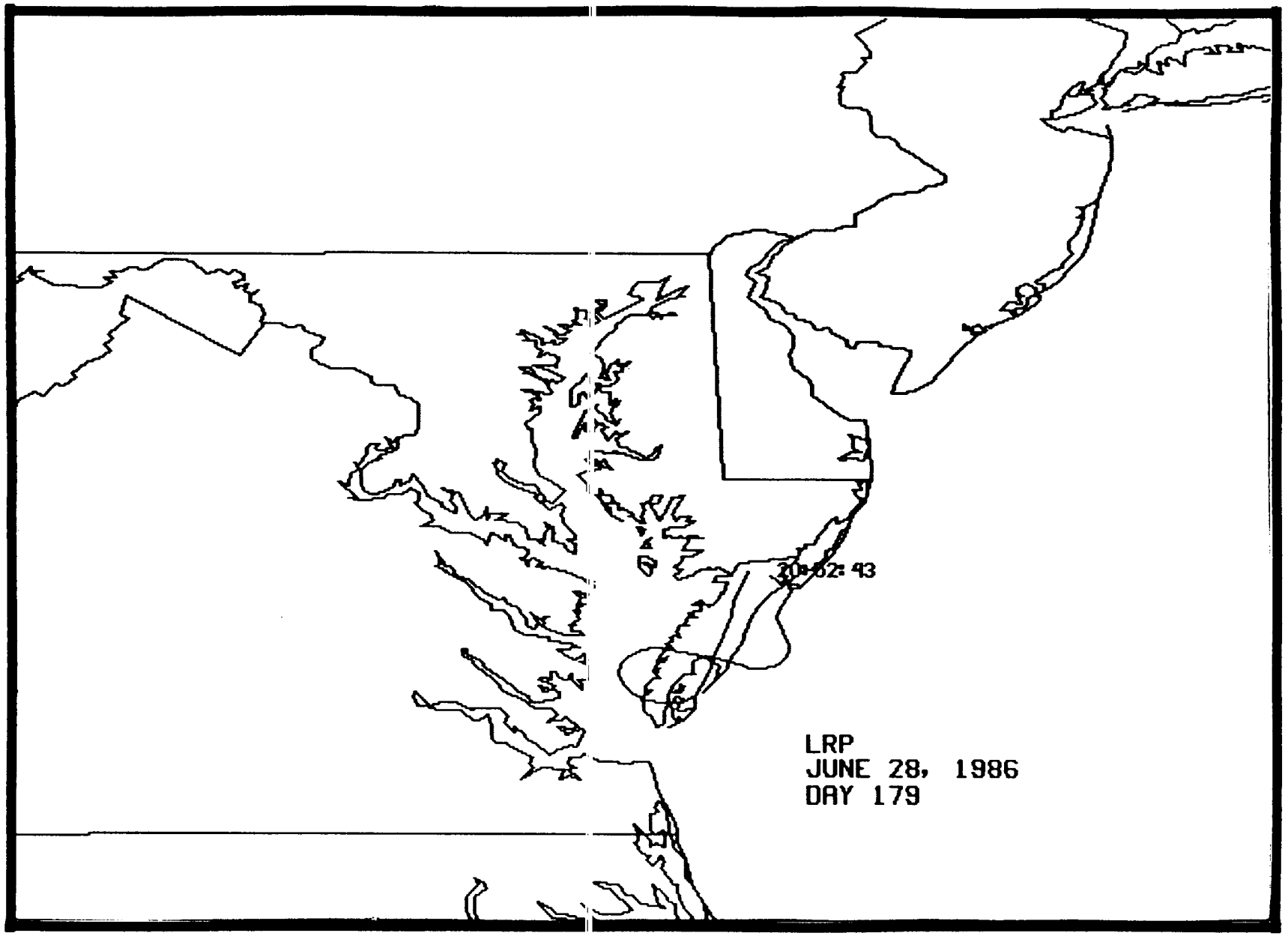

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HIS, MPR, MTS, MCR, AMMS, CLS, LIP
JUNE 23, 1986
DAY 174

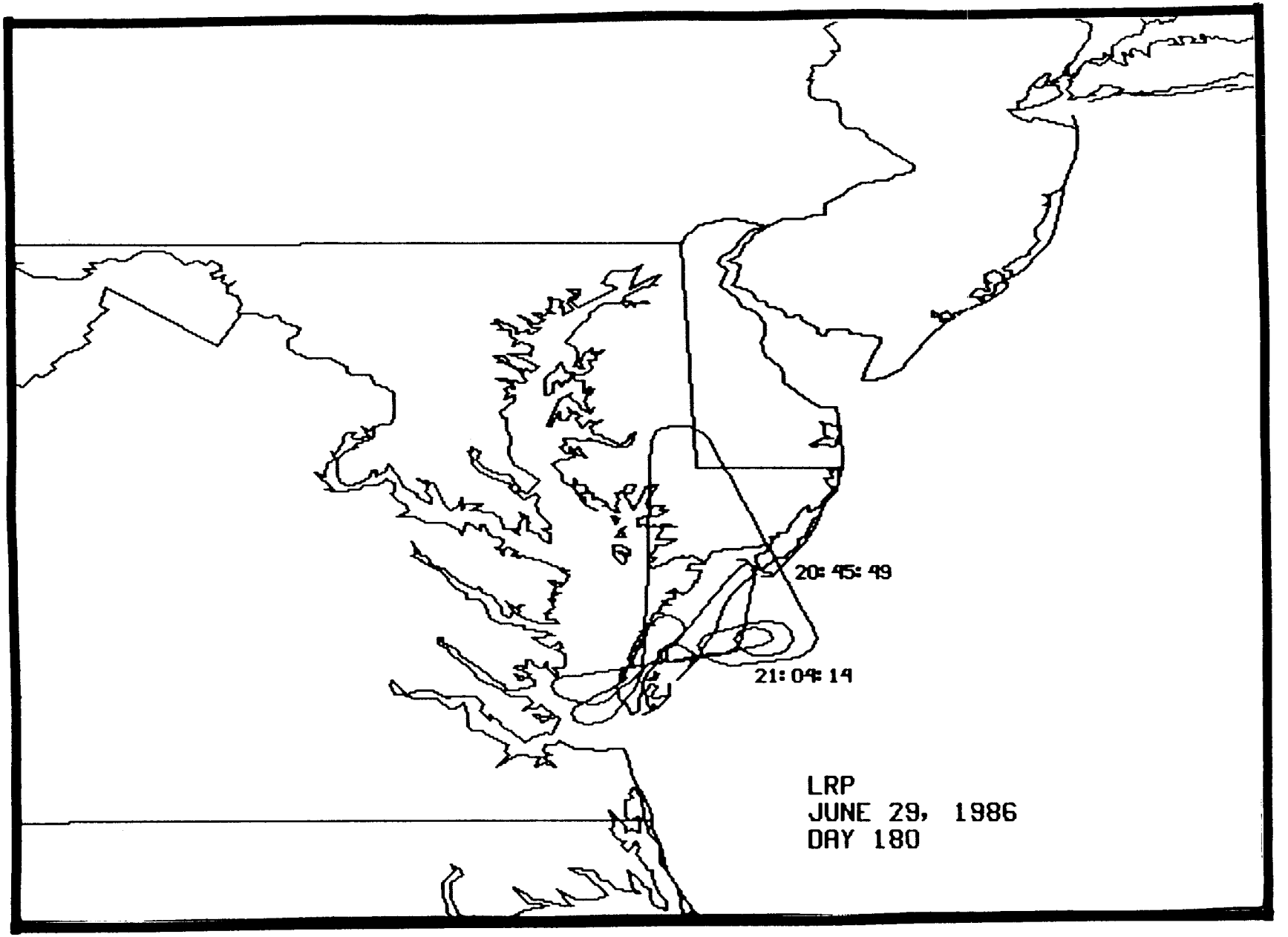

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20: 51: 39
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LRF
JUNE 24, 1986
DAY 175

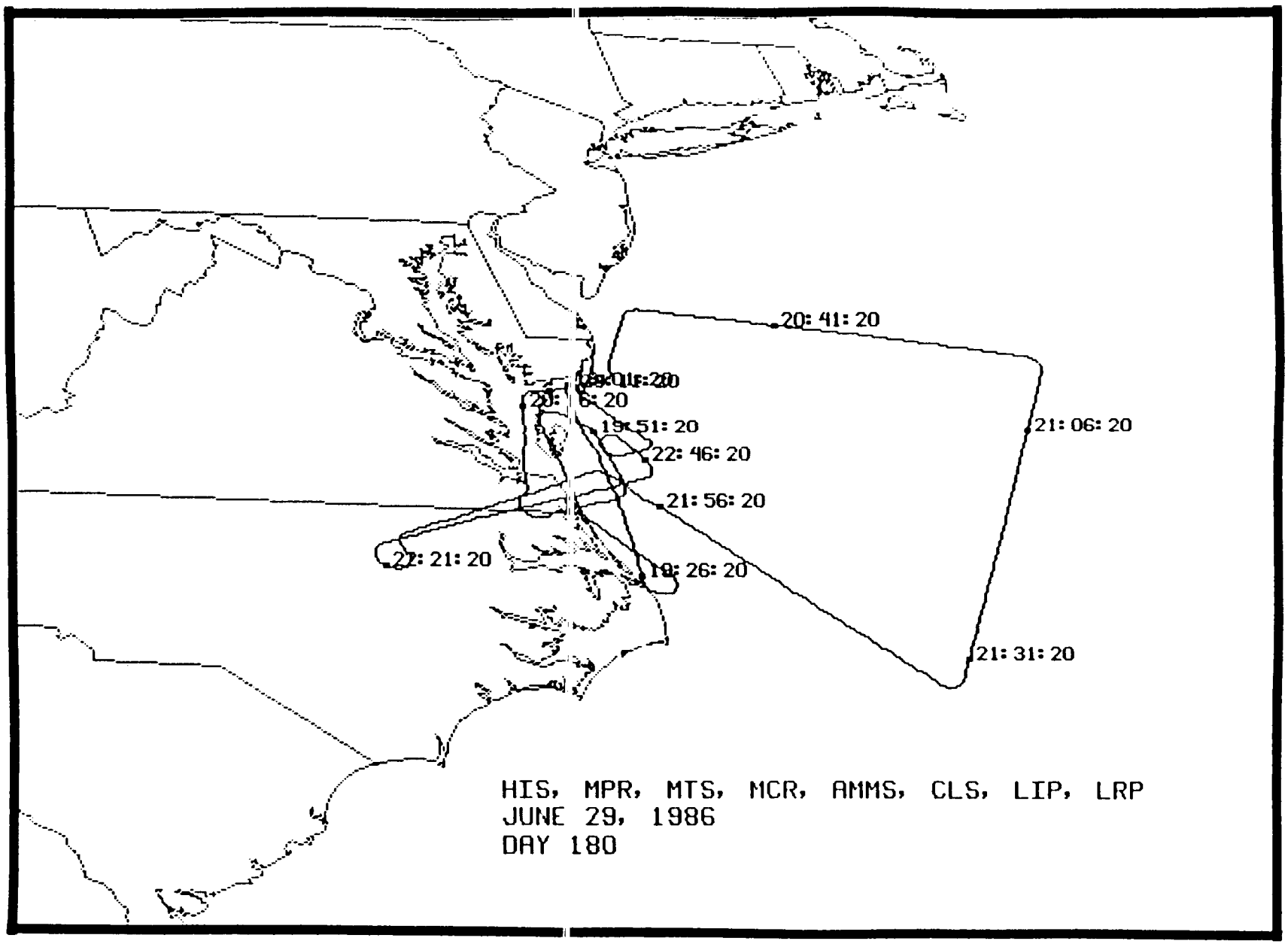

15: 09: 08
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16: 39: 08
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MAMS, HIS
JUNE 26, 1986
DAY 177
17: 39: 08

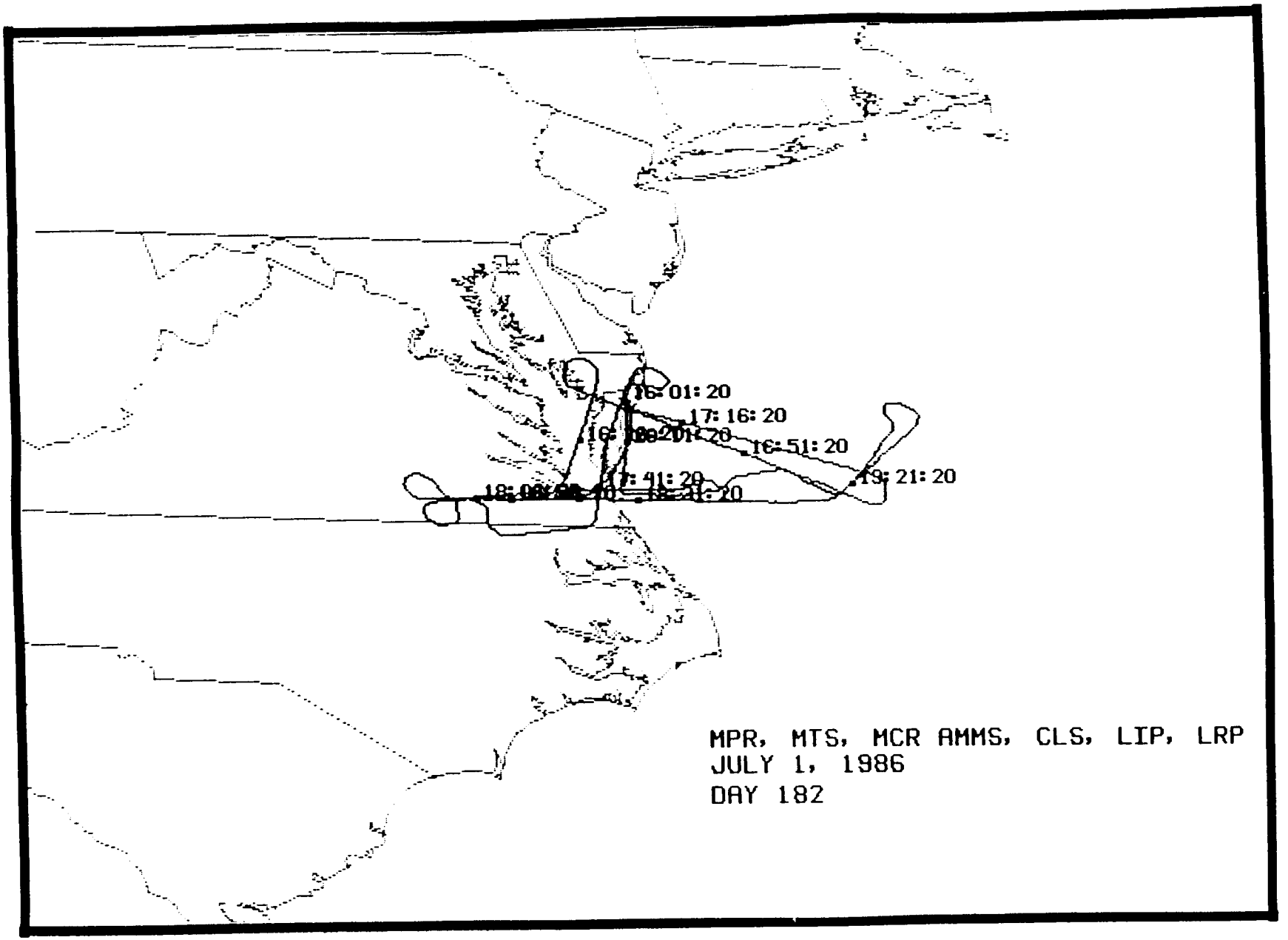

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21:00:30
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MPR, MTS, MCR, AMMS, CLS, LIP
JUNE 27, 1986
DAY 178

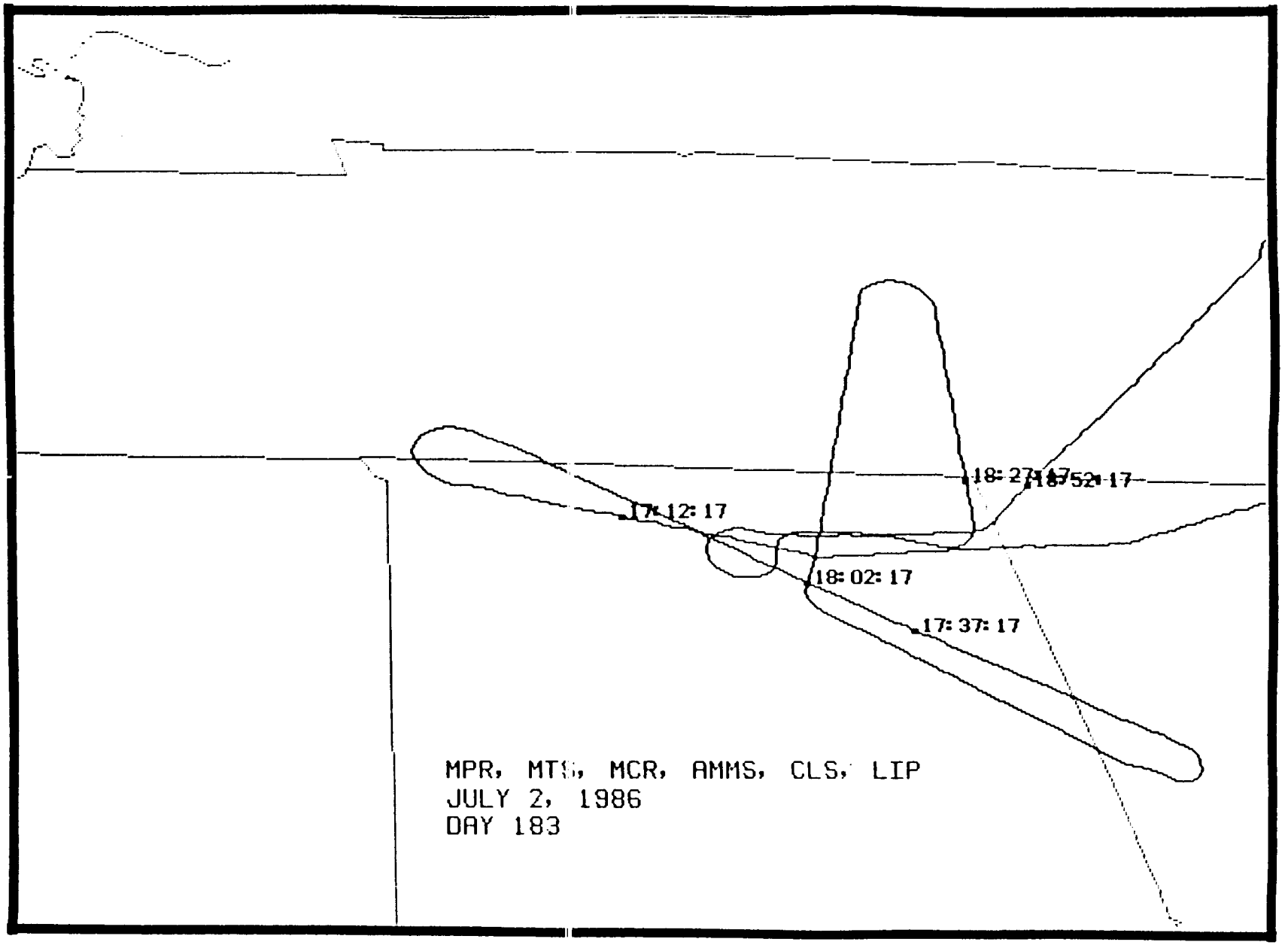

15: 58
20: 55: 12
22: 13: 39
MPR, MTS, MCR, AMMS, CLS, LIP
JUNE 28, 1986
DAY 179


LRP
JUNE 28, 1986
DAY 179


20: 45: 49
21: 04: 14
LRP
JUNE 29, 1986
DAY 180


20: 41: 20
21: 06: 20
19: 51: 20
22: 46: 20
21: 56: 20
22: 21: 20
21: 31: 20
HIS, MPR, MTS, MCR, AMMS, CLS, LIP, LRP
JUNE 29, 1986
DAY 180

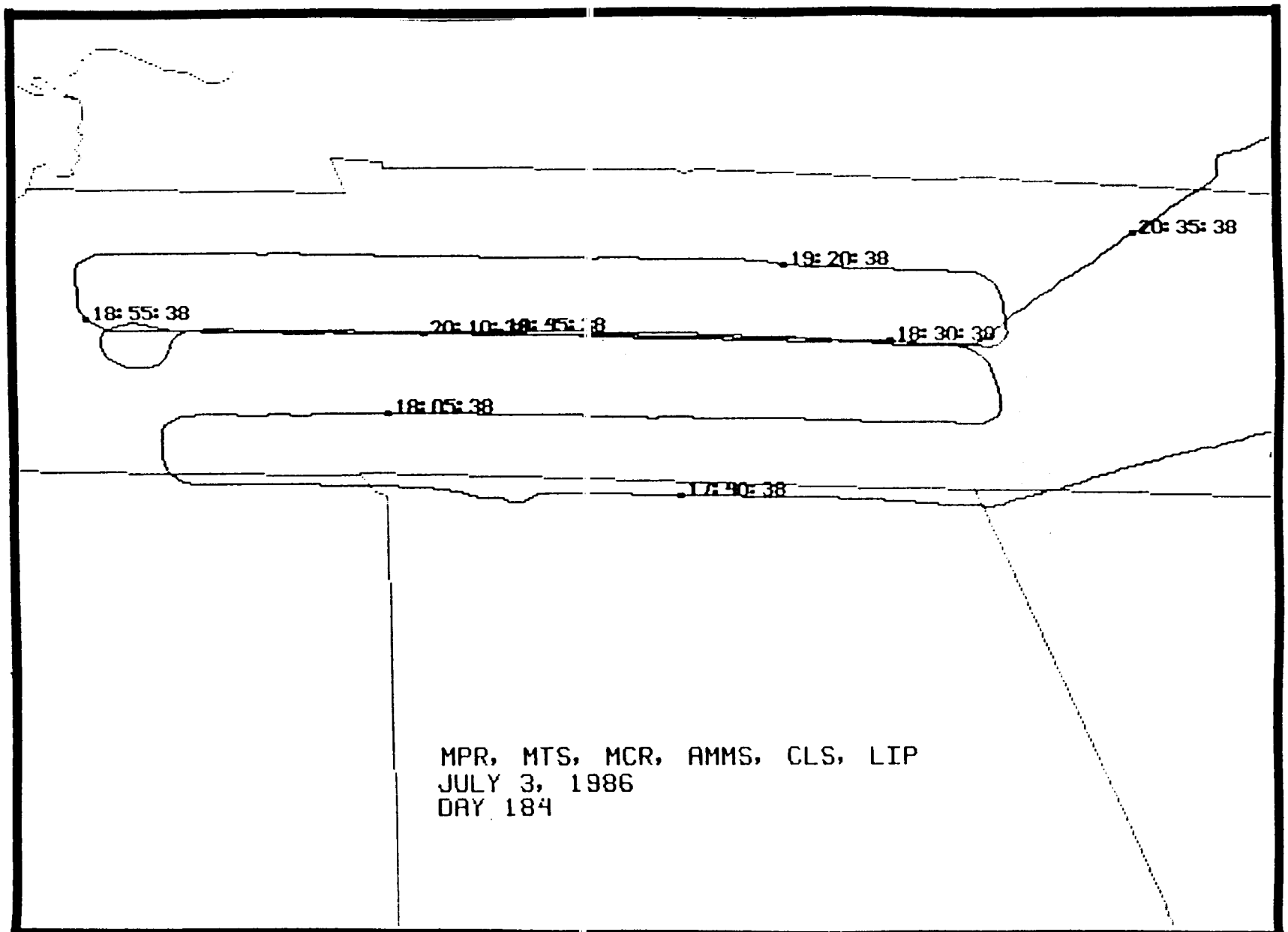

16: 01: 20
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19: 21: 20
MPR, MTS, MCR AMMS, CLS, LIP, LRP
JULY 1, 1986
DAY 182

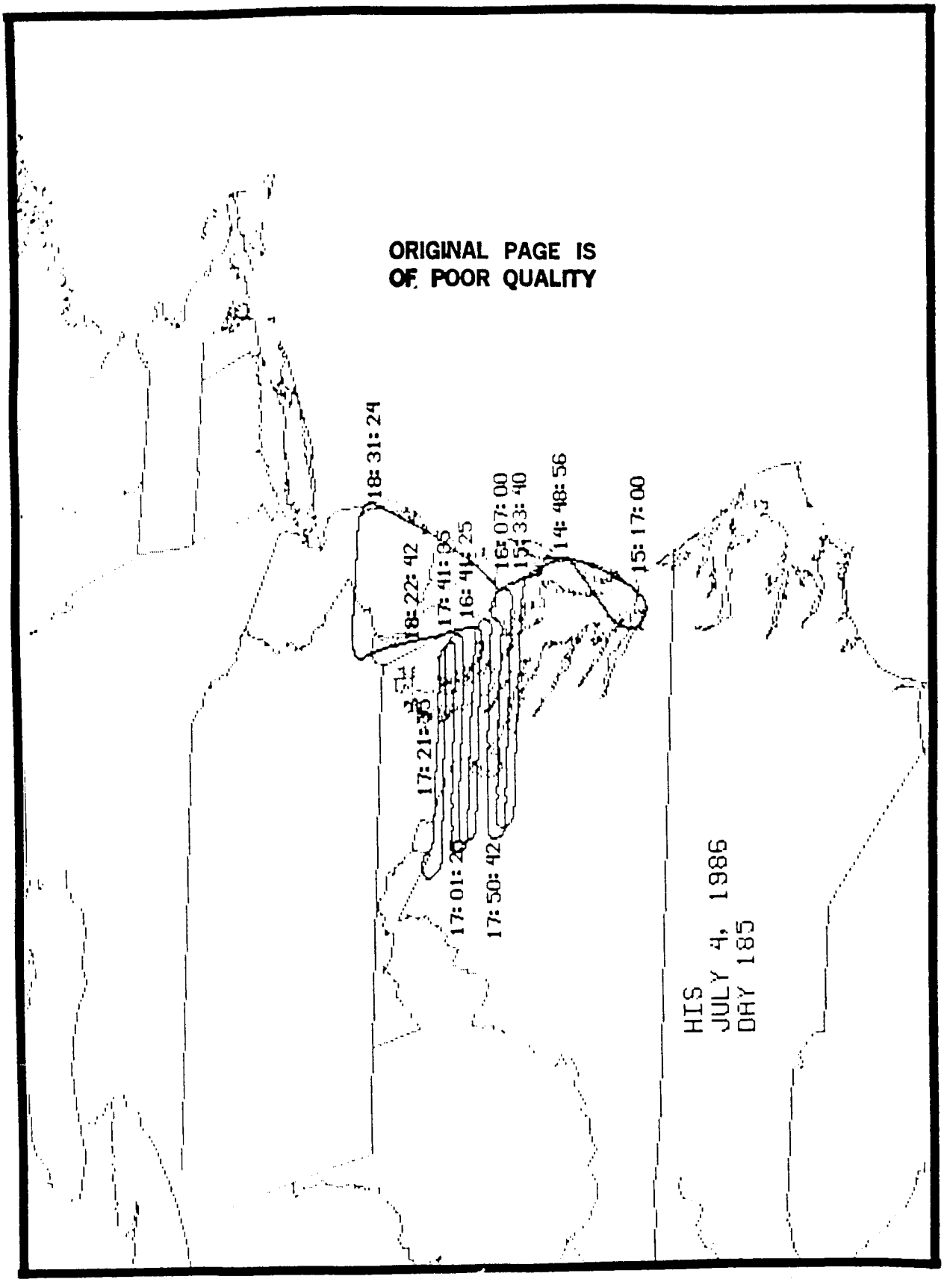

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18:52:17
18:02:17
17:37:17
MPR, MTS, MCR, AMMS, CLS, LIP
JULY 2, 1986
DAY 183

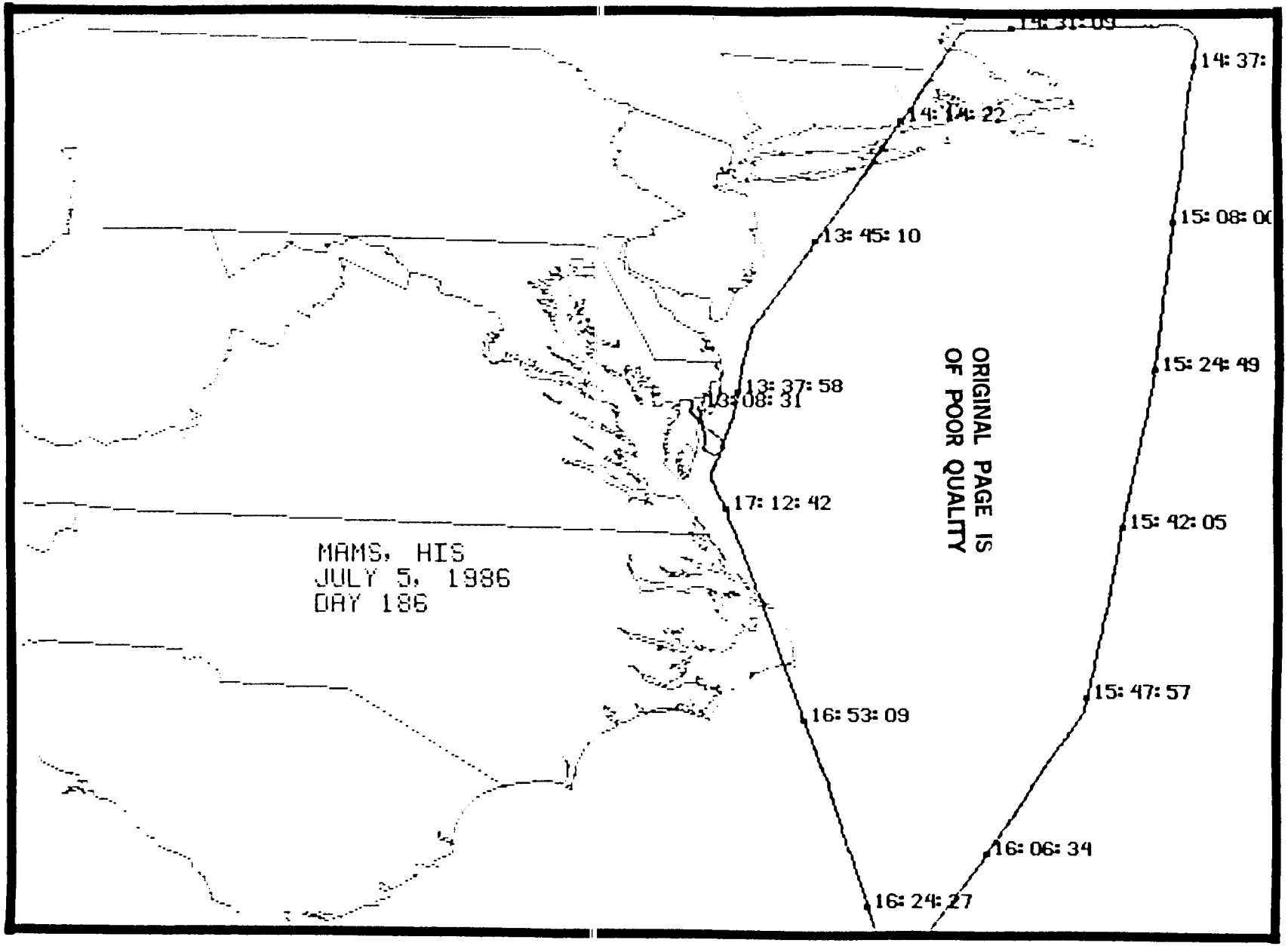
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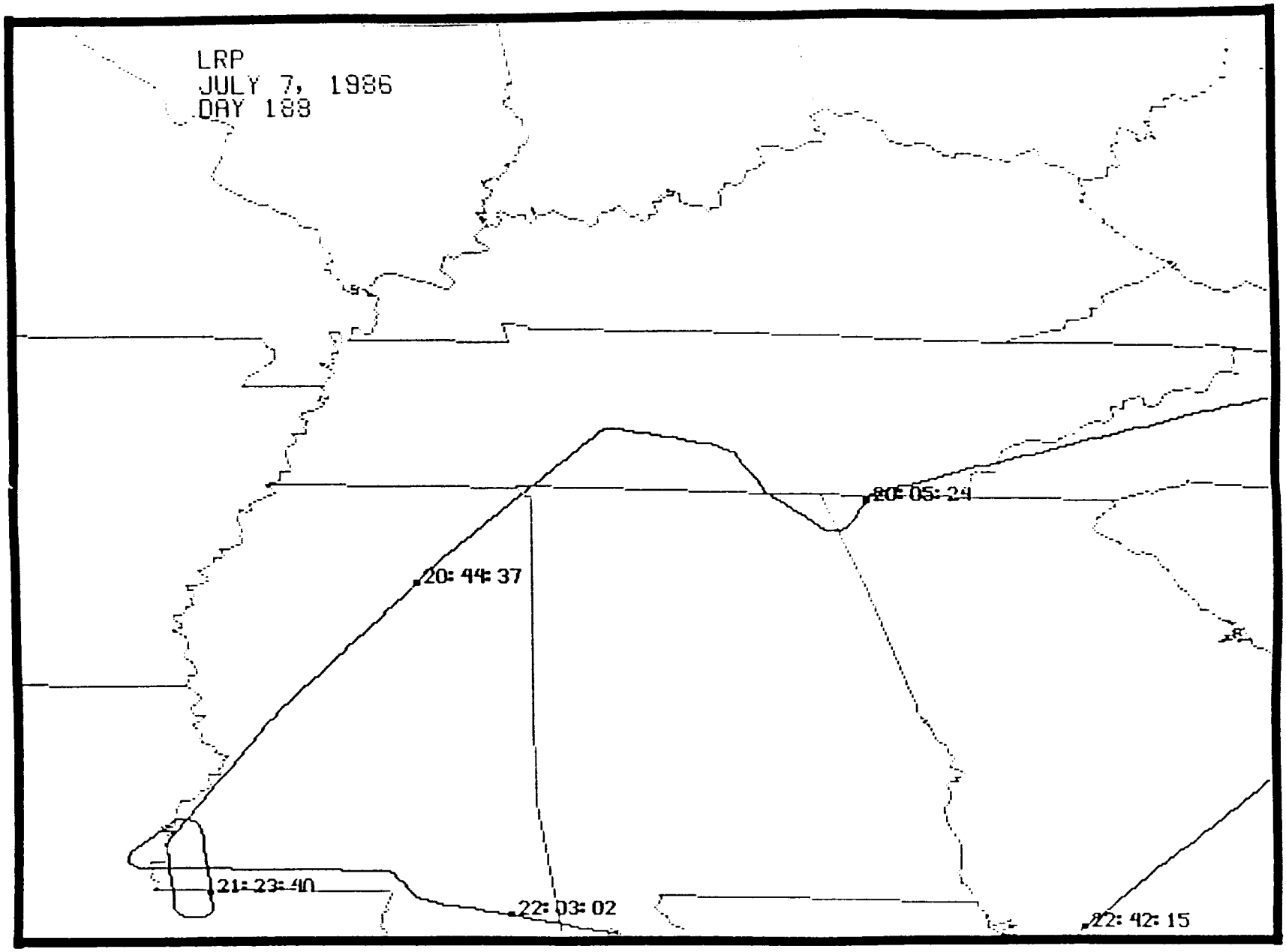
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MAMS, HIS
JULY 3, 1986
DAY 184

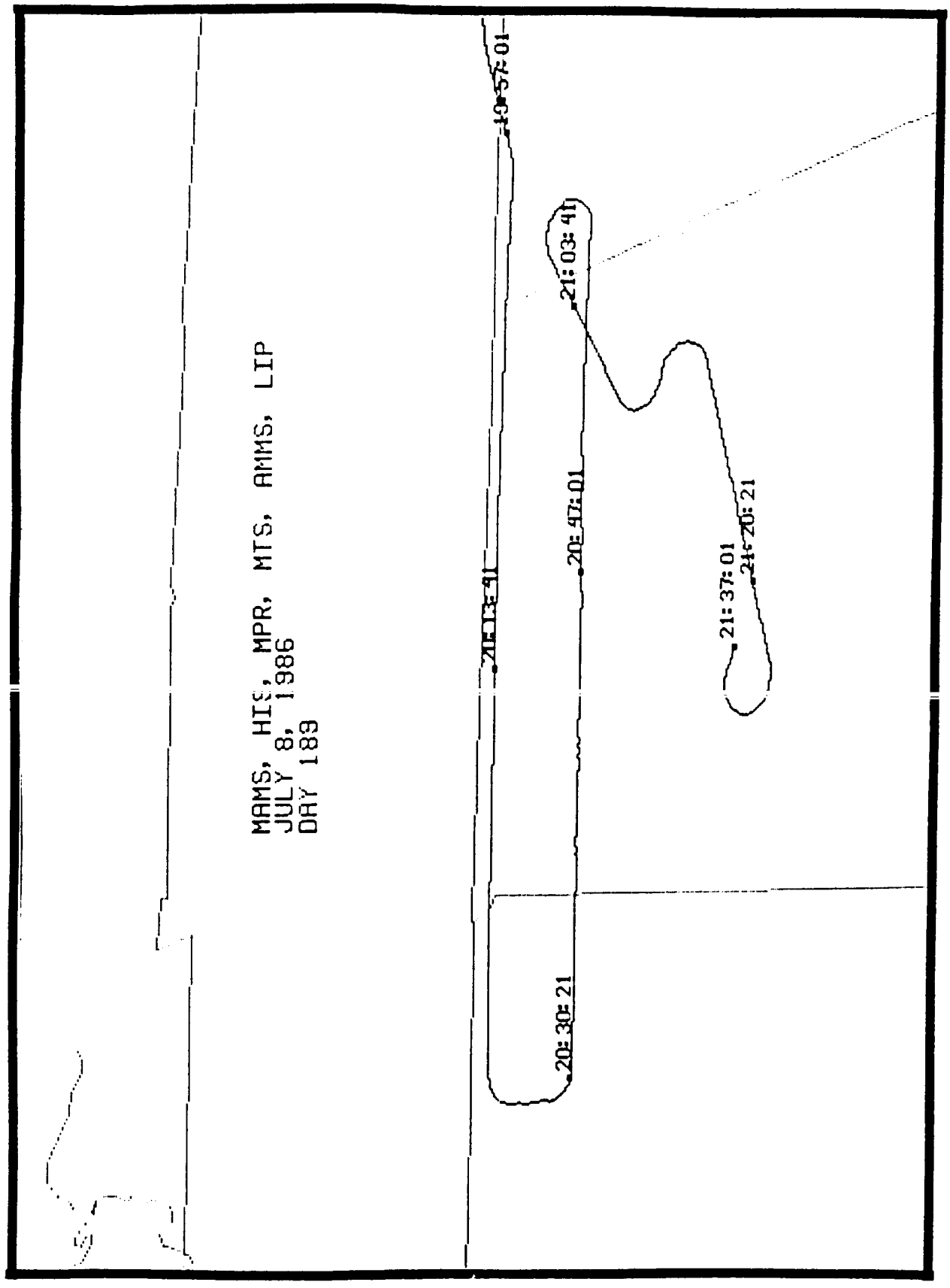

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18: 05: 38
MPR, MTS, MCR, AMMS, CLS, LIP
JULY 3, 1986
DAY 184

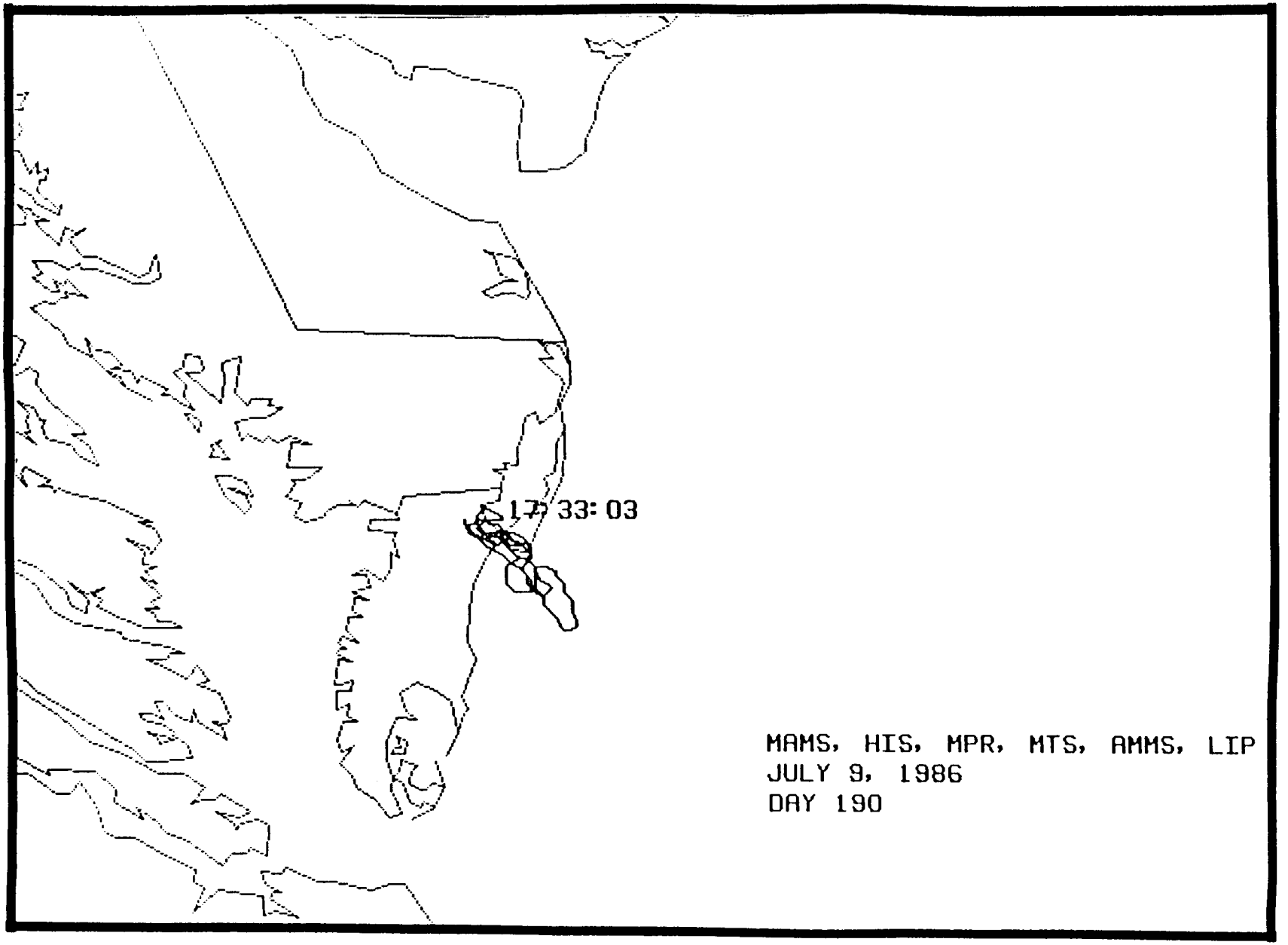

ORIGINAL PAGE IS
OF POOR QUALITY
18: 31: 24
18: 22: 42
17: 41: 05
16: 41: 25
16: 07: 00
15: 33: 40
14: 48: 56
15: 17: 00
17: 21: 58
17: 01: 20
17: 50: 42
HIS
JULY 4, 1986
DAY 185


MAMS, HIS
JULY 5, 1986
DAY 186
13: 45: 10
13: 37: 58
13: 08: 31
17: 12: 42
16: 53: 09
16: 24: 27
16: 06: 34
15: 47: 57
15: 42: 05
15: 24: 49
15: 08: 0(
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14: 14: 22
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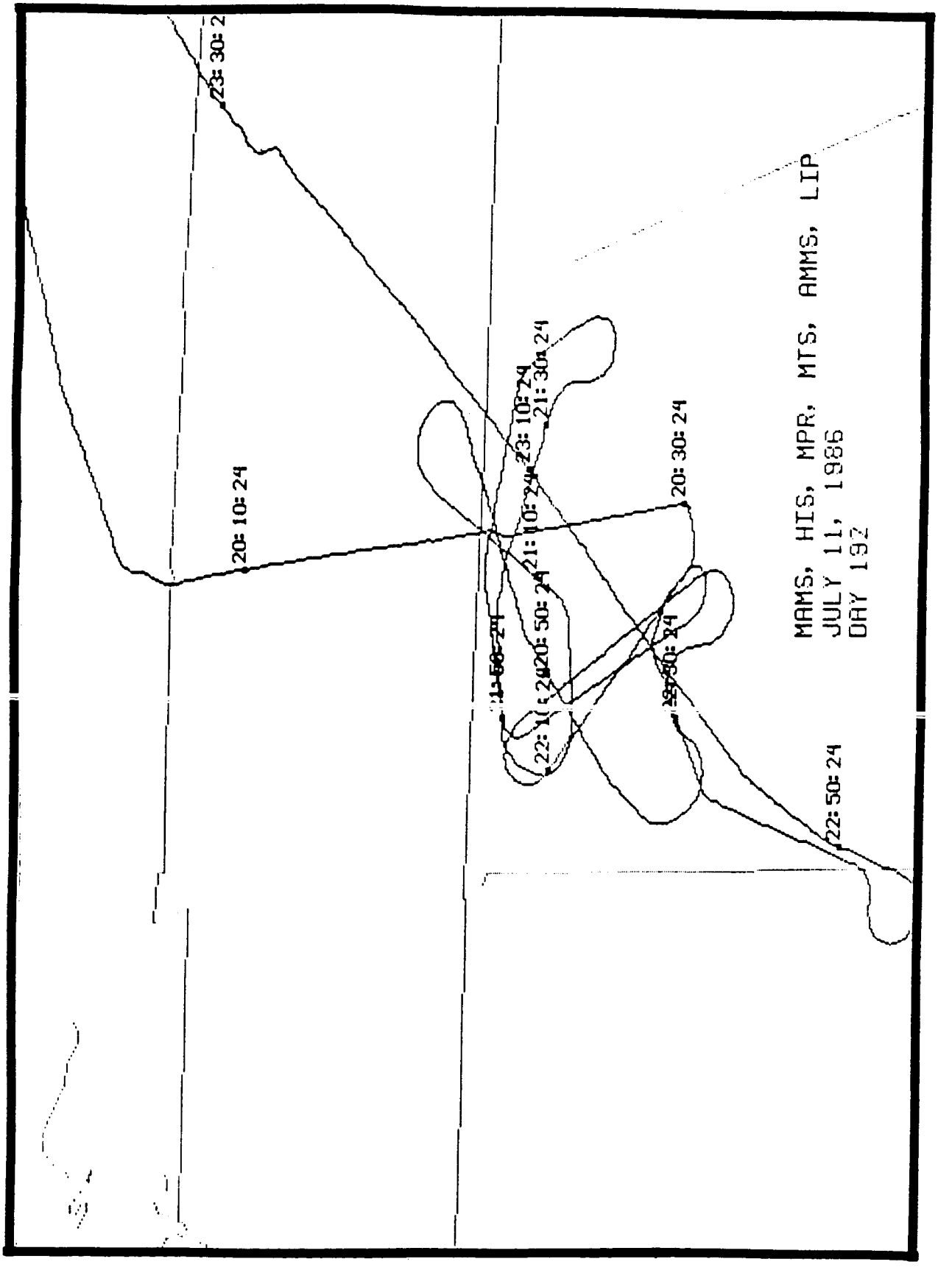

LRP
JULY 7, 1986
DAY 188
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22: 03: 02
22: 42: 15

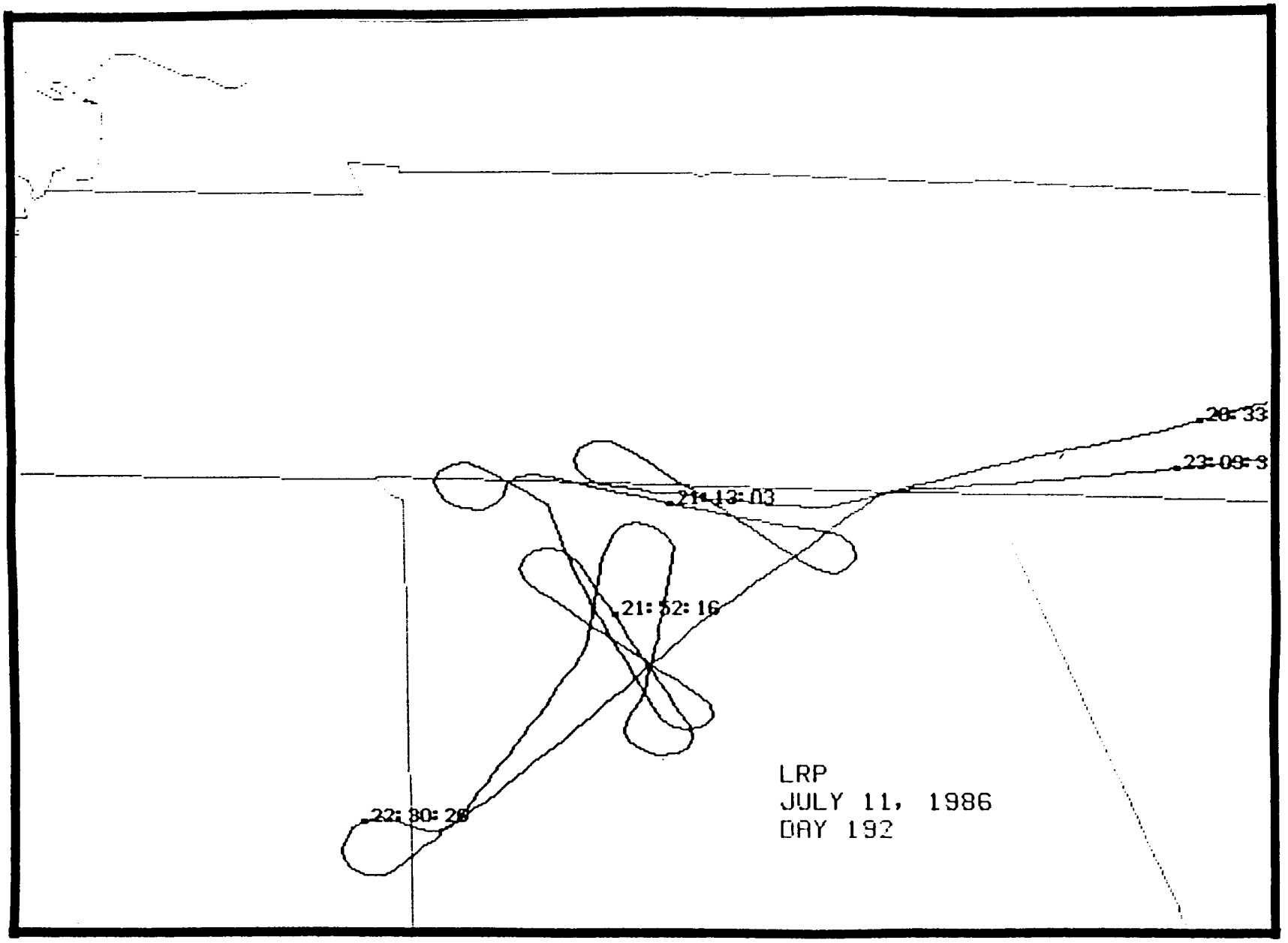
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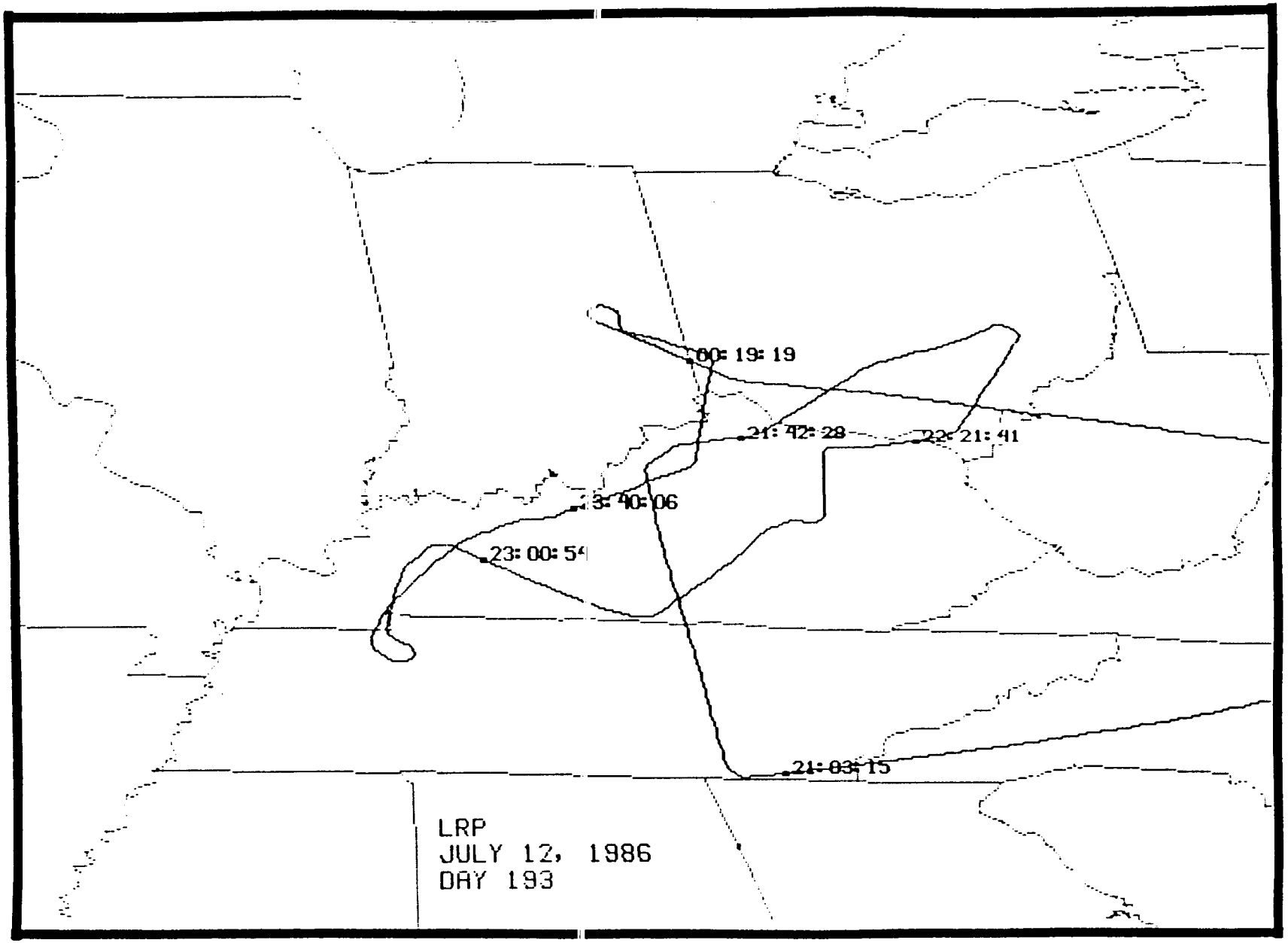


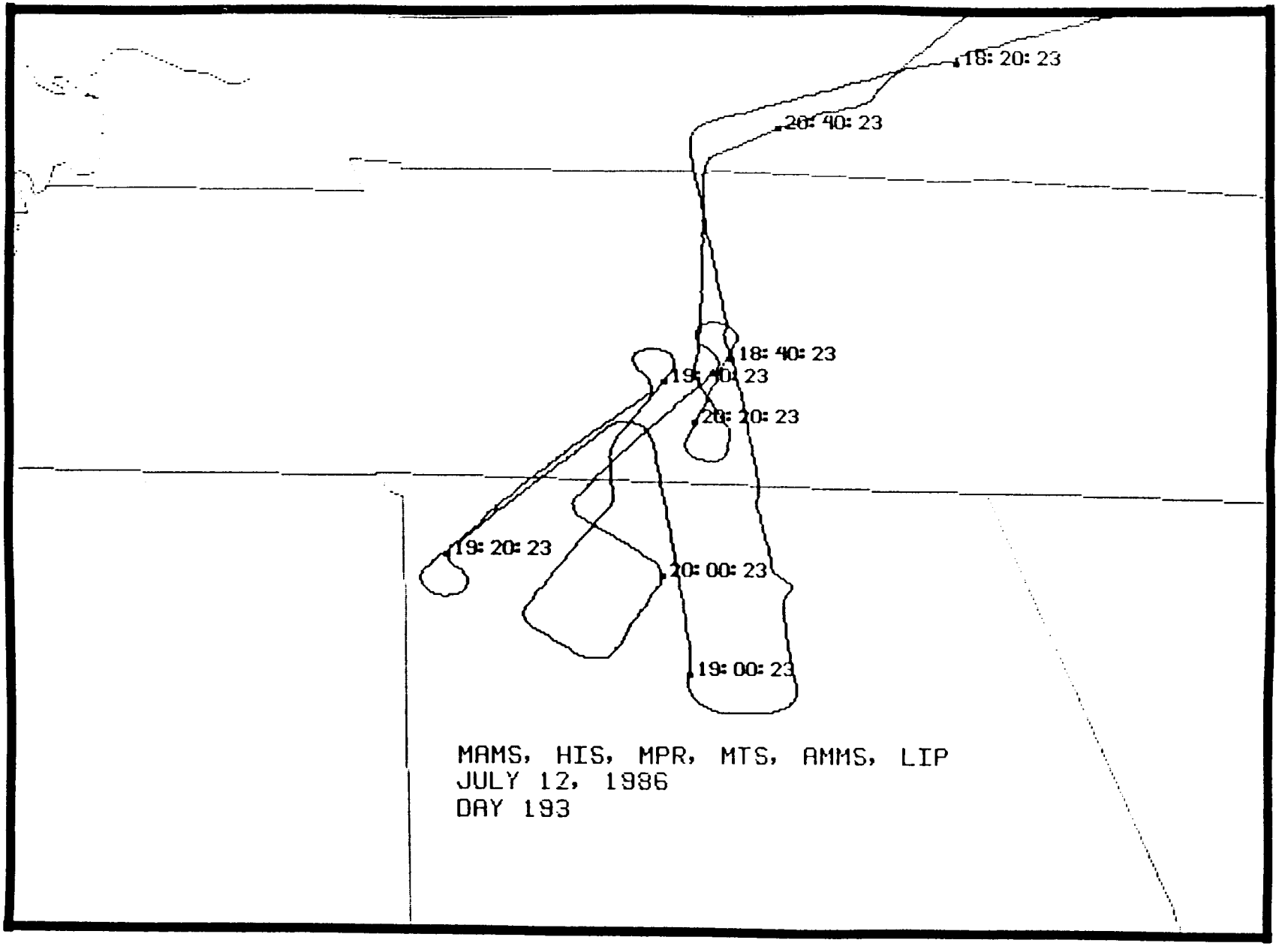

17: 33: 03
MAMS, HIS, MPR, MTS, AMMS, LIP
JULY 9, 1986
DAY 190

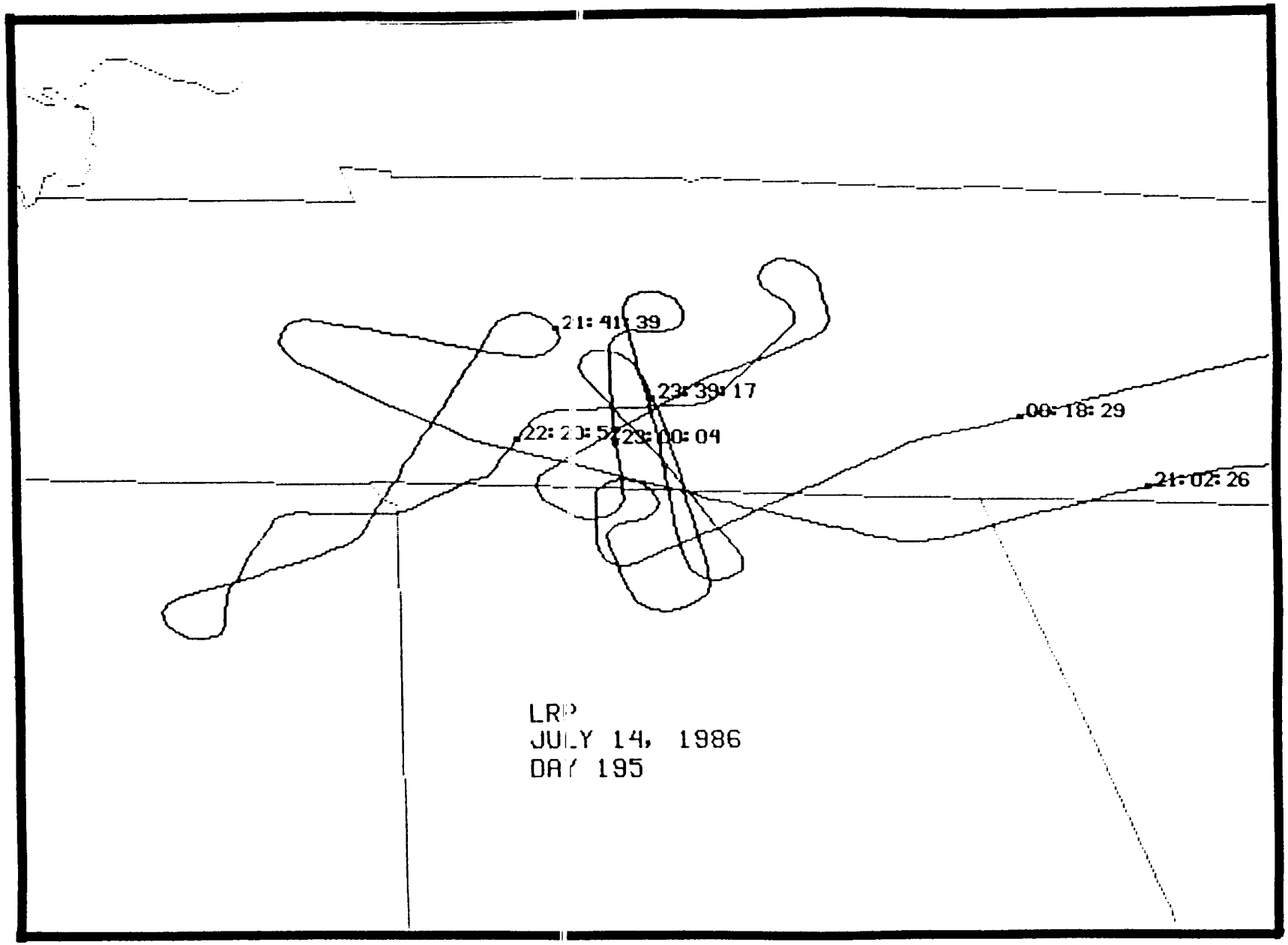
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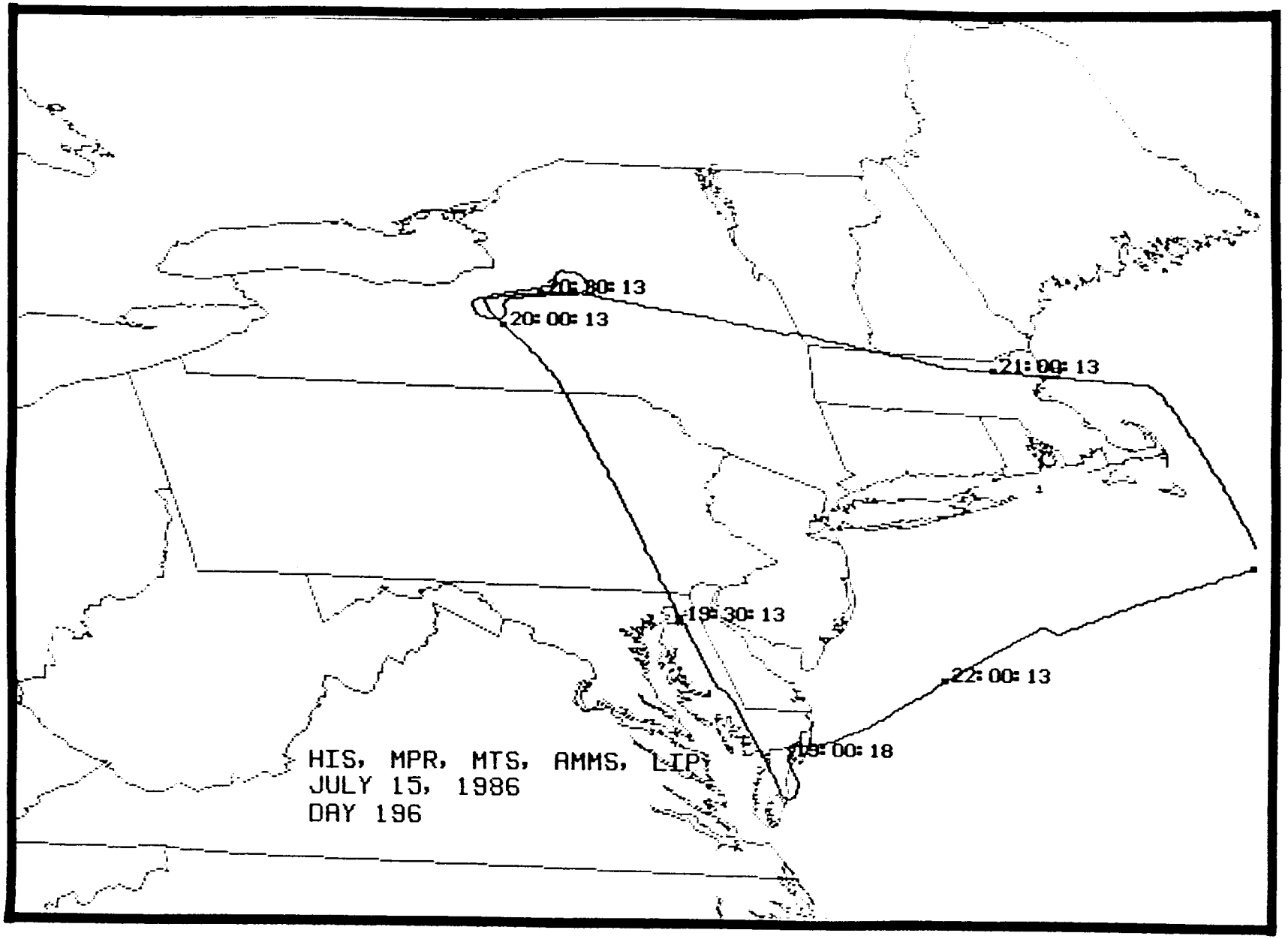


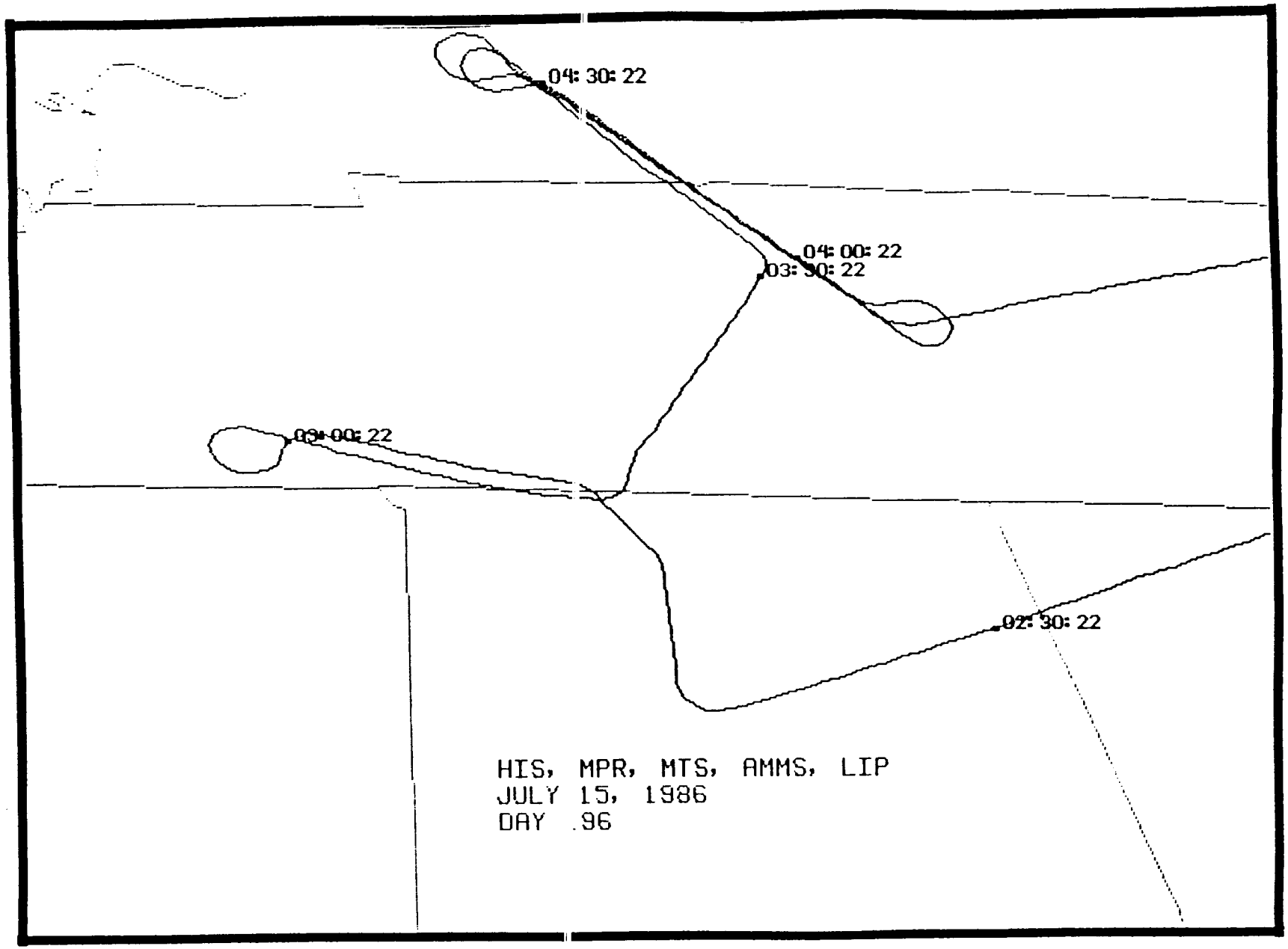

20:33
23:09:3
21:13:03
21:52:16
22:30:28
LRP
JULY 11, 1986
DAY 192


00: 19: 19
21: 42: 28
22: 21: 41
3: 40: 06
23: 00: 54
21: 03: 15
LRP
JULY 12, 1986
DAY 193

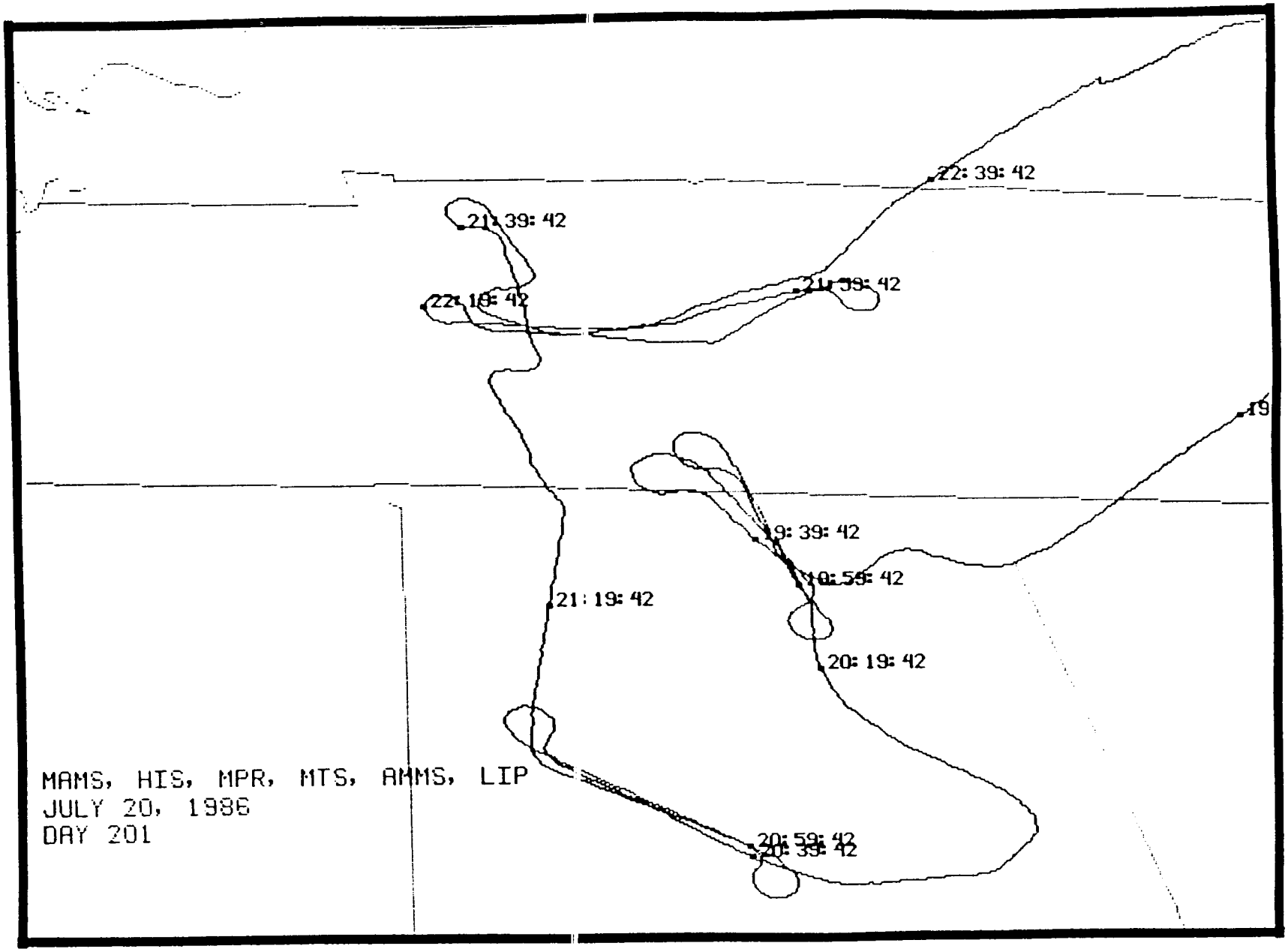

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19: 40: 23
20: 20: 23
19: 20: 23
20: 00: 23
19: 00: 23
MAMS, HIS, MPR, MTS, AMMS, LIP
JULY 12, 1986
DAY 193


21: 41: 39
23: 39: 17
22: 23: 57
23: 00: 04
00: 18: 29
21: 02: 26
LRP
JULY 14, 1986
DAY 195

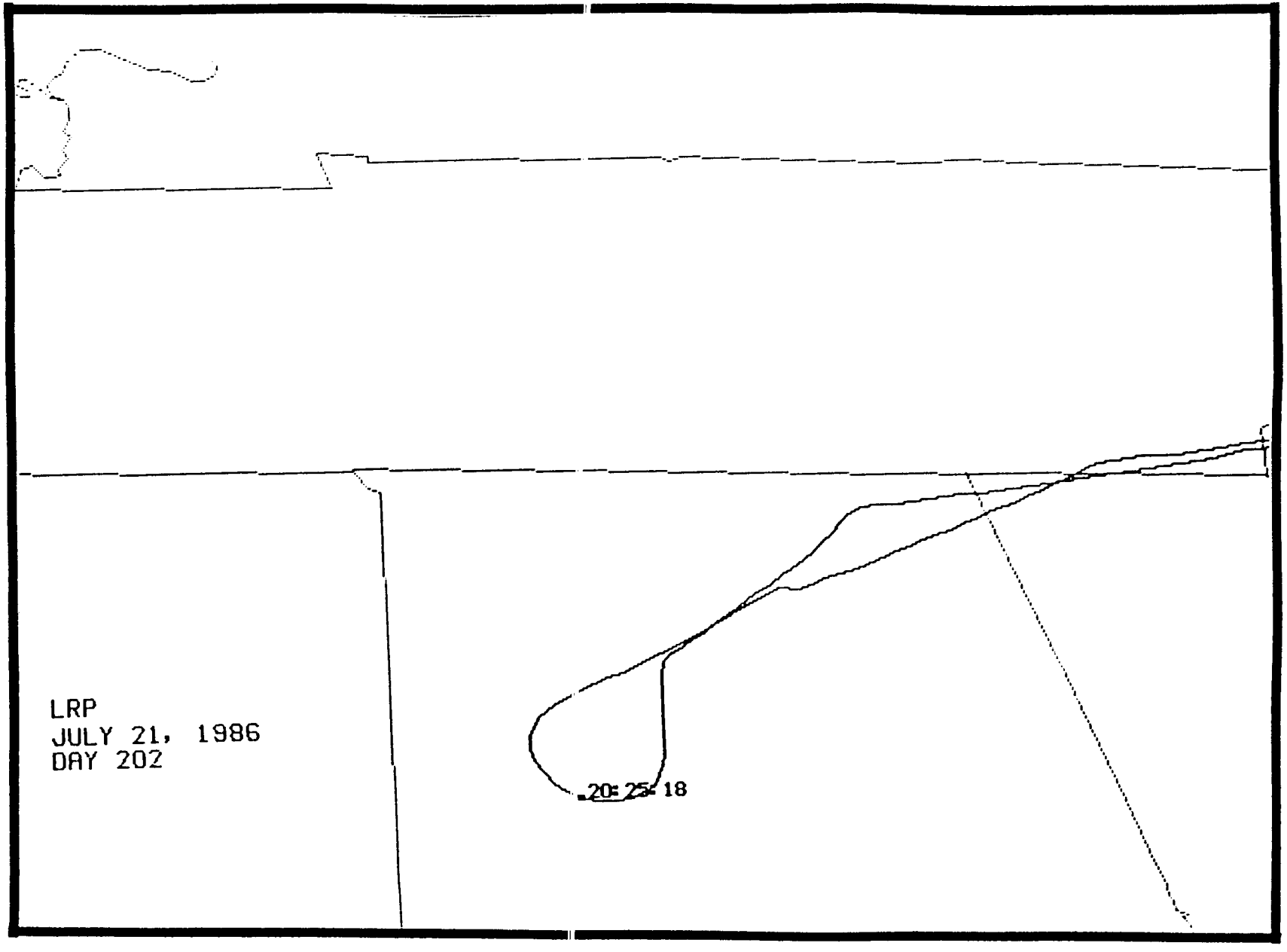

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HIS, MPR, MTS, AMMS, LIP
JULY 15, 1986
DAY 196

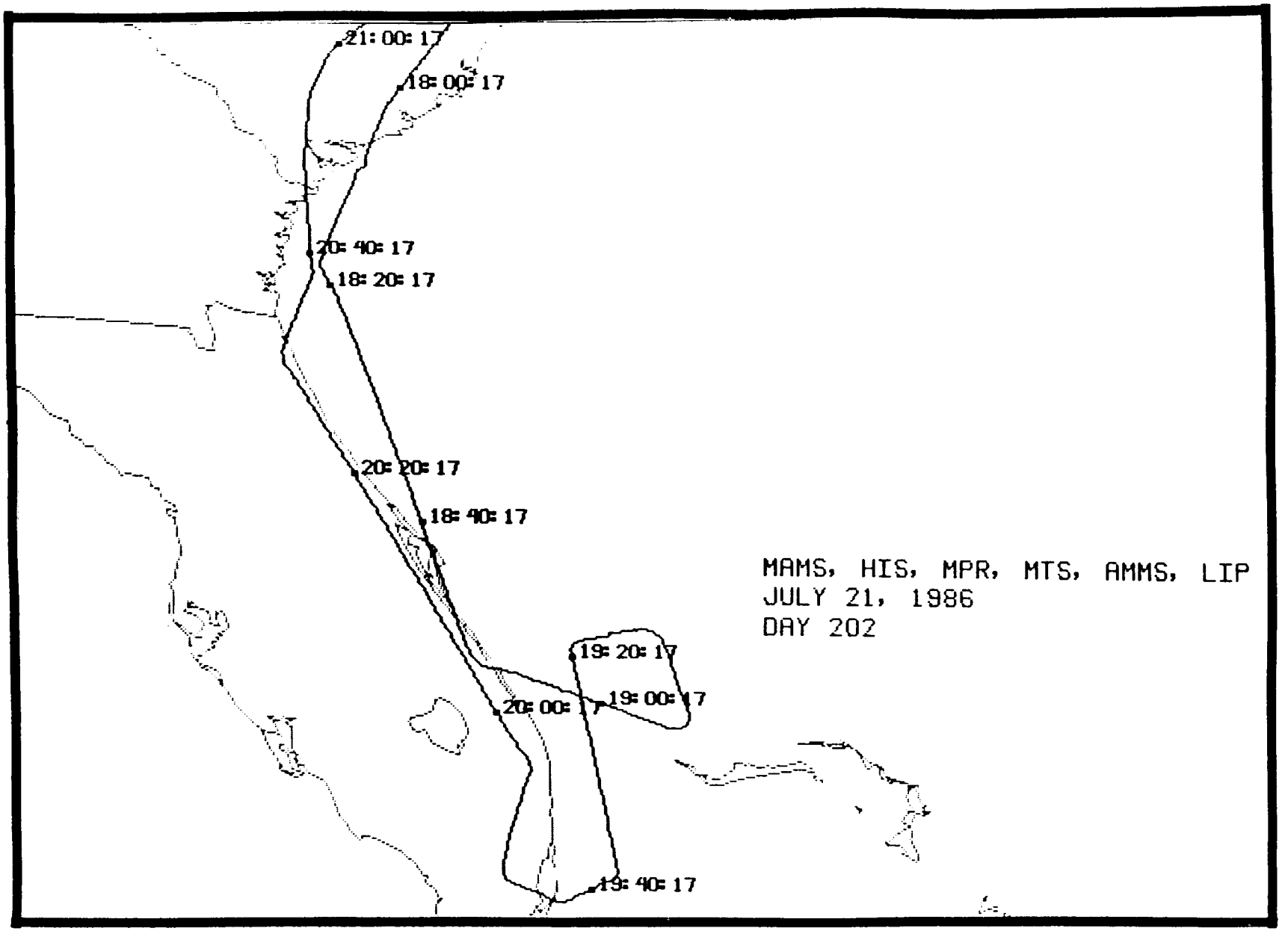

04: 30: 22
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03: 00: 22
02: 30: 22
HIS, MPR, MTS, AMMS, LIP
JULY 15, 1986
DAY 196

20:01:52
HIS, MPR, MTS, AMMS, LIP
JULY 17, 1986
DAY 198


22: 39: 42
21: 39: 42
22: 19: 42
21: 39: 42
19
19: 39: 42
21: 19: 42
20: 19: 42
MAMS, HIS, MPR, MTS, AMMS, LIP
JULY 20, 1986
DAY 201
20: 59: 42
20: 39: 42

21:19:43
22:00:04
20:38:21
LRP
JULY 20, 1986
DAY 201


LRP
JULY 21, 1986
DAY 202
20:25:18


21:00:17
18:00:17
20:40:17
18:20:17
20:20:17
18:40:17
19:20:17
19:00:17
20:00:17
19:40:17
MAMS, HIS, MPR, MTS, AMMS, LIP
JULY 21, 1986
DAY 202

APPENDIX B

LIST OF ACRONYMS

LIST OF ACRONYMS

ADAS	Automated Data Acquisition System
AGL	Above Ground Level
AMMS	Advanced Microwave Moisture Sounder
AMPR	Advanced Microwave Precipitation Radiometer
AVE	Atmospheric Variability Experiment
AVHRR	Advanced Very High Resolution Radiometer
BNA	Nashville, Tennessee
CALS	Cloud and Aerosol Lidar System
CCD	Charge Couple Device
CDT	Central Daylight Time
CIRES	Cooperative Institute for Research in Environmental Sciences
COHMEX	Cooperative Huntsville Meteorological Experiment
CMF	Common Mesonet Format
CSU	Colorado State University
DMSP	Defense Meteorological Satellite Program
EADS	Engineering Analysis and Data System
FA	Fast Antenna
FAA	Federal Aviation Administration
FAMS	FAA Automated Mesonet System
FLOWS	FAA-Lincoln Laboratory Operational Weather Study
FSSP	Forward Scattering Spectrometer Probe
FTS	Federal Telephone System
GALE	Genesis of Atlantic Lows Experiment
GMD	Ground Meteorological Detector
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
GSFC	Goddard Space Flight Center
HIRS	High-resolution Infrared Radiation Sounder
HIS	High-resolution Interferometer Spectrometer
HSV	Huntsville, Alabama
ICRAD	Interactive Color Radar Display
IFOV	Instantaneous Field Of View
INS	Inertial Navigation System
IR	Infrared
LIP	Lightning Instrumentation Package
LLP	Lightning, Location and Protection
LOA	List Of Acronyms
LRP	Lightning Research Package
MAMS	Multispectral Atmospheric Mapping Sensor
M^{c}IDAS	Man computer Interactive Data Analysis System
MCR	Multispectral Cloud Radiometer
MCS	Mesoscale Convective System
MIT/LL	Massachusetts Institue of Technology / Lincoln Laboratory
MIST	Microburst and Severe Thunderstorm
MPR	Microwave Precipitation Radiometer
MSFC	Marshall Space Flight Center
MSU	Microwave Sounding Unit
MTS	Microwave Temperature Sounder

NAMS	NASA Automated Mesonet System
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NESDIS	National Environmental Satellite Data Information Service
NEXRAD	Next Generation Radar
NGM	Nested Grid Model
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NSSDC	National Space Science Data Center
NSSL	Natioanl Severe Storms Laboratory
NWS	National Weather Service
OAO	Office of Aircraft Operations
OAS	Optical Array Sensor
OCS	Oklahoma Climatological Survey
OPS	Optical Pulse Sensor
OTSU	Omaha Technical Service Unit
PAM	Portable Automated Mesonet
PBL	Planetary Boundary Layer
PCM	Pulse Code Modulation
PMS	Particle Measuring Systems
PPI	Plane Position Indicator
PRF	Pulse Repetition Frequency
PSU	Pennsylvania State University
RADAP	Radar Data Processor
RHI	Range Height Indicator
RISOP	Rapid Interval Scan Operations Plan
RSA	Redstone Arsenal, Alabama
SA	Slow Antenna
SBUV	Solar Backscatter Ultraviolet
SDSM&T	South Dakota School of Mines and Technology
SMMR	Scanning Multi-channel Microwave Radiometer
SPACE	Satellite Precipitation And Cloud Experiment
SSEC	Space Science and Engineering Center
SSU	Stratospheric Sounding Unit
T_B	Brightness Temperature
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS Operational Vertical Sounder
TVA	Tennessee Valley Authority
UAH	University of Alabama at Huntsville
UC	University of Chicago
UCLA	University of California Los Angeles
UHF	Ultra High Frequency
UND	University of North Dakota
UW	University of Wisconson
VAD	Velocity Azimuth Display
VAS	VISSR Atmospheric Sounder
VCR	Video Cassette Recorder
VHF	Very High Frequency

VHS	Video Home System
VISSR	Visible and Infrared Spin Scan Radiometer
WAD	Wide Angle Detector
WBAN	Weather Bureau, Air Force, and Navy
WFF	Wallops Flight Facility
WSR	Weather Service Radar

APPENDIX C

LIST OF COHMEX INVESTIGATORS AND PARTICIPANTS

APPENDIX C

Table C-1. COHMEX Data Archival and Principal Investigators

DATA TYPE	ARCHIVE INSTITUTION	CONTACT PERSON
	Sounding Systems	
Rawinsonde Network	UAH, MSFC	Mr. Steven F. Williams, UAH
Raman Lidar	GSFC	Dr. Harvey Melfi, GSFC
UHF Wind Profiler	PSU	Dr. Greg Forbes, PSU
Doppler Sodar	PSU	Dr. Greg Forbes, PSU
	Radars	
CP-2 Doppler Radar	NCAR	Dr. Greg Forbes, PSU Dr. V. N. Bringi, CSU
CP-3 Doppler Radar	NCAR	Dr. T. T. Fujita, UC Dr. Roger Wakimoto, UCLA
CP-4 Doppler Radar	NCAR	Dr. T. T. Fujita, UC Dr. Roger Wakimoto, UCLA
FL-2 Doppler Radar	MIT/LL	Mr. Paul J. Biron, MIT/LL
UND Doppler Radar	UND	Dr. Leon Osborne, UND
RADAP (Nashville)	UAH, MSFC	Dr. Kevin R. Knupp, UAH Mr. Robert Saffle, NWS
ICRAD	USRA, MSFC	Mr. Dennis Buechler, USRA
Kavouras	MSFC	Mr. Steven J. Goodman, USRA/MSFC
	Remote Sensors	
AMMS	GSFC	Dr. Thomas Wilheit
MPR	MSFC	Dr. Roy Spencer
MTS	MIT	Dr. Al Gasiewski
MCR	GSFC	Dr. James Spinhirne
CALS	GSFC	Dr. James Spinhirne
LIP	MSFC	Dr. Richard Blakeslee
LRP	MSFC	Dr. Richard Blakeslee
MAMS	MSFC	Mr. Gary Jedlovec, MSFC
HIS	UW, MSFC	Dr. William L. Smith

	Aircraft	
T-28 Aircraft	SDSM&T	Dr. Dennis Musil, SDSM&T
Cessna Citation Aircraft	UND	Dr. Dan Burrows, UND
NOAA P-3	UC	Dr. T. T. Fujita, UC
Cessna T207 Aircraft	CSU	Dr. Peter Sinclair, CSU
	Satellites	
GOES Central Satellite	MSFC, UW	Dr. James E. Arnold, MSFC
NOAA 9 Satellite	NESDIS	NESDIS
DMSP Satellite	CIRES	Mr. Greg Scharfen, CIRES
Nimbus 7 Satellite	NSSDC	Dr. Arnold Oaks, GSFC
	Surface Systems	
PAM-II Mesonet	NCAR	Dr. T. T. Fujita, UC Dr. R. Wakimoto, UCLA
FAA Mesonet	MIT/LL	Mr. Paul J. Biron
NASA Mesonet	UAH, MSFC	Mr. Steven F. Williams, UAH
TVA Raingage Network	UAH, MSFC	Mr. H. Michael Goodman, UAH
LLP Network	MSFC	Mr. Steven J. Goodman, USRA/MSFC
Mobile Laboratory	NSSL	Dr. David Rust, NSSL
Other Surface Systems	UAH, MSFC	Mr. Steven F. Williams, UAH

Table C-2. Address and Phone List of Active COHMEX Participating Organizations and Major Personnel

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Department of Atmospheric Science
Ft. Collins, CO 80523

Dr. Peter Sinclair (Cessna T207)	(303) 491-8670

Colorado State University
Department of Electrical Engineering
Ft. Collins, CO 80523

Dr. V. N. Bringi (CP-2)	(303) 491-5595
Dr. J. Vivekanandan (CP-2)	(303) 491-7678
Dr. V. Chandrasekar (CP-2)	(303) 491-7678

Cooperative Institute for Meteorological Satellite Studies (CIMSS)
University of Wisconsin
1225 West Dayton Street
Madison, WI 53706

Dr. William L. Smith (HIS, VAS)	(608) 264-5325
Dr. Ben Howell (HIS)	(608) 264-5325
Dr. Paul Menzel (MAMS, GOES)	(608) 264-5325

Cooperative Institute for Research in Environmental Sciences (CIRES)
DMSP Archives National Snow and Ice Center
University of Colorado / Campus Box 449
Boulder, CO 80309

Mr. Greg Scharfen (DMSP)	(303) 492-5171

Florida State University
Department of Meteorology
Love Building
Tallahassee, FL 32306

Dr. Henry Fuelberg (GOES, VAS)	(904) 644-6466
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16. ABSTRACT

During the period June through July 1986, NASA conducted the Satellite Precipitation and Cloud Experiment (SPACE) in the central Tennessee, northern Alabama, and northeastern Mississippi area. In addition to SPACE, the MIcroburst and Servere Thunderstorm (MIST) Program, sponsored by the National Science Foundation, and the FAA-Lincoln Laboratory Operational Weather Study (FLOWS), sponsored by the Federal Aviation Administration, operated concurrently under the acronym of COHMEX (COoperative Huntsville Meteorological EXperiment). The COHMEX field program incorporated measurements from remote sensors flown on high altitude aircraft (ER-2 and U-2), Doppler and conventional radars, rawinsondes, satellites, cloud physics research aircraft, and various surface observational systems.

This document contains a brief description of the field program and a daily data collection summary. Chapter 2 summarizes the program instrumentation and facilities, and includes sample selected data products. Chapter 3 provides a meteorological summary, operations overview, and an inventory of the data collected for each day of the field program. The purpose of this document is to provide the researcher and scientist with a tool to select data sets for case studies and instrument evaluation.

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